

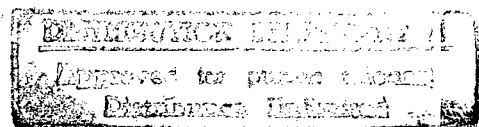


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# ***JPRS Report***

# **Science & Technology**

***USSR: Materials Science***



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# Science & Technology

## USSR: Materials Science

JPRS-UMS-91-001

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28 JANUARY 1991

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UDC 620.179.16

**Acoustical Signal Sensor for High-Precision Measurements**

907D0154A Sverdlovsk DEFEKTOSKOPIYA in Russian  
No. 3, Mar 90 pp 30-38

[Article by A. I. Kondratyev, V. A. Lugovoy, "Dalstandart" Scientific-Production Association]

[Abstract] Capacitive acoustical signal sensors consist of two electrodes, between which is either an air gap or a dielectric film. The air gap makes the device insensitive, while the dielectric film causes sensitivity which decreases over time. A suggestion was made to eliminate these problems—a sensor with an electrode made of aluminum, while the dielectric layer is obtained by anodizing the electrode in a solution of oxalic acid. The second electrode is the object studied. A comparative analysis is presented on such a device with the characteristics of an optical interferometer and piezoelectric receiver. The capacitive sensor with thin-film dielectric is said to be a unique sensor for high-precision measurement of acoustical quantities. It features good technical characteristics, non-contact operation, convenient certification by means of an optical interferometer, ease of use, simplicity of manufacture and good reproducibility of technical characteristics. Figures 3; References 21: 17 Russian, 4 Western.

UDC 620.179.16

**Problems of Adjustment of Depth-Measurement Devices in Ultrasonic Defectoscopes Type UD-11PU and UD-12**

907D0154B Sverdlovsk DEFEKTOSKOPIYA in Russian  
No. 3, Mar 90 pp 42-50

[Article by S. L. Molotkov, Scientific Research Institute of Bridges, Leningrad Institute of Railroad Engineering imeni Academician V. N. Obroztsov]

[Abstract] Analysis of the methods used to adjust a depth-measuring defectoscope indicates that the method based on the use of two reflectors has certain faults. Attempts are made to eliminate these shortcomings and simplify the process. The procedure of tuning the defectoscope is divided into two independent stages: Zero setting and assignment of the angular coefficient. Only one point is required in the second stage. Figure 1; References 6: Russian.

UDC 620.179.16

**Effectiveness of Use of Pulse-Period CO<sub>2</sub> Lasers for Defectoscopy of Metals**

907D0154C Sverdlovsk DEFEKTOSKOPIYA  
in Russian No. 3, Mar 90 pp 51-57

[Article by N. P. Biryukova, V. Ye. Schabanov, et al.]

[Abstract] Experimental studies are described on the selection of optimal laser parameters for excitation of

ultrasonic signals for defectoscopy. The possibility of using various types of lasers is analyzed, and several problems in the use of lasers are found. First, operation in the energy range most suitable for defectoscopy, at  $\lambda = 10.6 \mu\text{m}$  is difficult, requiring optics made of special materials and conditions difficult to achieve in practice. In CO<sub>2</sub> lasers it is also difficult to achieve pulses shorter than 100 ns. The use of longer pulses imparts insufficient energy to the object being tested. Furthermore, CO<sub>2</sub> laser pulses always include "tails" containing 50 - 60 percent of the pulse energy which simply heats the specimen. Periodic-pulse CO<sub>2</sub> lasers are also large, with masses of 1 - 2 tons, making their use in non-destructive testing difficult. Figures 11; References 5: 4 Russian, 1 Western.

UDC 621.317.39

**Instrument for Checking Coating Integrity**

907D0154D Sverdlovsk DEFEKTOSKOPIYA  
in Russian No. 3, Mar 90 pp 80-81

[Article by L. V. Roshchupkina]

[Abstract] A device for testing the integrity of coatings is suggested, it is designed to check the quality of paint and varnish, enamel and other coatings applied to metal bases. The operation of the device is based on the electric contact method, by measurement of the electrical resistance of the circuit formed in a metal base to which a protective coating has been applied by means of an electrolyte (a weak NaCl solution) filling the porosity zone and a special contact. The instrument is supplied with a set of interchangeable contacts of various sizes and shapes. The technical characteristics are presented in table form. Production testing indicated that the device is reliable in recording continuity defects in coatings of 0.1 mm<sup>2</sup> or larger. References 1: Russian.

UDC 620.165.29

**Helium Mass-Spectrometer Leak Finder With Oil-Free Vacuum Pump**

907D0154E Sverdlovsk DEFEKTOSKOPIYA in Russian  
No. 3, Mar 90 pp 81-82

[Article by A. I. Yevlampiyev, L. D. Muravyeva]

[Abstract] One of the basic operations of the manufacturing cycle of many products is leak testing, presently performed with series-produced mass-spectrometer leak finders, the vacuum system of which contains oil-vapor diffusion pumps and mechanical oil-containing pumps. A new helium mass spectrometer leak finder, the type TIM2T, has been produced to provide a fully oil-free manufacturing technology. The vacuum pump on the device is a special turbomolecular pump with magnetic rotor suspension, manufactured of light alloys. The mass of the pump is 9.5kg and it operates at 100 l/s. The device is capable of recording a

helium flow of  $5 \times 10^{-14}$  Pa.m<sup>3</sup>/s in high-sensitivity mode with accumulation time of 1 minute. Figure 1; References 2, Russian.

UDC 620.179.15

### Automatic Radio Defectoscope

907D0154F Sverdlovsk DEFECTOSKOPIYA in Russian No 3, Mar 90 pp 82-84

[Article by A. A. Ganibalov, Yu. D. Pervitskiy, et al., Leningrad Institute of Electric Engineering imeni V. I. Ulyanov (Lenin)]

[Abstract] An automatic radio defectoscope is described, designed for non-destructive testing of cylindrical objects, such as dielectric coatings on metal cylinders, thin metal films on dielectric cylinders and the surface condition of dielectric and metal cylinders. The automatic device moves the products and its testing sensors as necessary according to a stored program, then separates rejects from good products. The products are loaded into a storage hopper, then leave the machine in two channels for rejected and accepted products.

UDC 620.179.14

### PKTO-3 Device for Quality Testing of Heat Treatment

907D0154G Sverdlovsk DEFECTOSKOPIYA in Russian No 3, Mar 90 pp 84-85

[Article by I. A. Pleshakov, A. N. Deryavin, et al., Volgograd Polytechnical Institute]

[Abstract] A new model coercimeter with electromagnetic attachment is described; it is recommended for testing of the hardness and other mechanical characteristics of heat-treated parts and rolled shapes of carbon and alloy steels, and for determination of depths and hardness of the surface-hardened layer in parts following hardening with induction heating or chemical and heat treatment, and for sorting of parts by types of steel. The device is not intended for series or mass production and was therefore not tested by the state. It was tested at the Volga Pipe Plant and at other enterprises for non-destructive testing of the mechanical properties of hot-worked and welded pipe of various types of steels.

UDC 620.179.152

### Optimal Measurement Range of Local Pipe Wall Thickness by Combined Radiation Method

907D0154H Sverdlovsk DEFECTOSKOPIYA in Russian No 3, Mar 90 pp 85-86

[Article by L. A. Drabkin, All-Union Scientific Research Institute of the Pipe Industry]

[Abstract] The problem of determining the range of most effective use of a source of radiation must be solved in the development of thickness measurement devices utilizing the combined radiation method of measurement of the local thickness of pipe walls. The criterion generally used is the minimum relative measurement error for two independent detectors recording the direct and scattered radiation. This article presents equations for the relative measurement area as a function of wall thickness using various natural sources of ionizing radiation. It is concluded that increasing the effectiveness of collection of scattered radiation can achieve more accurate measurement than selection of the optimal radiation energy. Figures 2; References 4, Russian.

UDC 620.179.16

### Influence of Acoustical Contact on Transfer Properties of "Object-Transducer" System

907D0154I Sverdlovsk DEFECTOSKOPIYA in Russian No 3, Mar 90 pp 86-88

[Article by V. B. Batuyev, A. I. Gorbunov, et al., "Dalstandart" Scientific- Production Association]

[Abstract] Results are presented from studies of the influence of roughness of an object and contact fluid used on the amplitude-frequency characteristics of the "object-transducer" system. Studies were performed at 0.02 to 2 Mhz with a wide band transducer on steel rectangular specimens. The studies showed that some lubricants have good transparency at low frequencies, but reduced transparency at higher frequencies. A second group has reduced transparency at all frequencies with increasing roughness. The best surface contact lubricants for objects with rough surfaces are glycerin and castor oil. Figure 1; References 3, Russian.



UDC 539.213:669:539.319

**Normal and Anomalous Stress Relaxation in Metallic Glasses**

907D0159A Kiev METALLOFIZIKA in Russian  
Vol 12 No 3, May-Jun 90 pp 37-41

[Article by A.T. Kosilov, V.A. Khonik, and T.N. Ryabtseva, PI (not further identified), Voronezh]

[Abstract] Specimens of metallic glasses  $\text{Co}_{51}\text{Ni}_{10}\text{Fe}_5\text{B}_{15.5}\text{Si}_{10.5}$  and  $\text{Fe}_{82}\text{B}_{12}\text{Si}_4\text{C}_2$ ,  $\text{FeCoCrNiSiBMo}$  obtained by melt spinning were strained and unstrained in tension at rates of  $4 \times 10^{-5}$  and  $1 \times 10^{-4} \text{ s}^{-1}$ , respectively, in a tensile machine that for the sake of rigidity was not equipped with a force-measurement device. The stresses were calculated from a relationship between the stress and the resonance frequency, length, and density of the specimens. It was found that anomalous stress relaxation (stress increase with time) occurs in metallic glasses, just as in crystalline materials, when the external load is reduced. A dislocation model that accounts for anomalous stress relaxation is presented. Figures 4; References 20: 11 Russian, 9 Western.

UDC 539.26:539.213:669.15:539.421.4

**Structure and Thermal Stability of  $(\text{FeCr})_{85}\text{B}_{15}$  Amorphous Alloys in the Initial Condition and After  $\gamma$ -Irradiation**

907D0159B Kiev METALLOFIZIKA in Russian  
Vol 12 No 3, May-Jun 90 pp 48-52

[Article by G. M. Zelinskaya, D. Yu. Paderno, V. V. Maslov, A. G. Ilinskiy, and M. P. Krulikovskaya, Metals-Physics Institute, Kiev, and Physics Institute, Ukrainian SSR Academy of Sciences, Kiev]

[Abstract] An X-ray ( $\text{Mo K}_\alpha$ ) diffraction study of the effect of  $^{60}\text{Co}$   $\gamma$ -irradiation and chromium content of  $(\text{Fe}_{100-x}\text{Cr}_x)_{85}\text{B}_{15}$  amorphous alloys (in which  $x$  was varied between 0 and 34) on their atomic structure and thermal stability is reported. The ratio of the temperature at which crystallization begins (which is indicated by a lowering of the electrical resistance) to the liquidus temperature was used as a measure of the thermal stability. It was found that the specimens differed in their nonuniformity of the topological and composition ordering, which affects their thermal and radiation stability. The thermal stability of the amorphous state increases with chromium content. It is about 0.430 without chromium, 0.457 at  $x = 5$ , and 0.517 at  $x = 32$ . Gamma-irradiation was found to result in disordering of the atomic structure and activation of crystallization in the case of specimens that contain some crystalline phase. Figures 6; Tables 1; References 6 Russian.

UDC 539.43:620.187.5:669.721.5

**Effect of Vacuum on Cyclic Hardening and Formation of Dislocation Substructure in Aluminum Alloy AMg6**

907D0159C Kiev METALLOFIZIKA in Russian  
Vol 12 No 3, May-Jun 90 pp 78-84

[Article by V. A. Serdyuk, N. M. Grinberg, A. M. Gavrilyako, D. V. Lychagin, and E. V. Kozlov, FTINT (Physico-Technical Institute for Low Pressures, Ukrainian SSR Academy of Sciences)]

[Abstract] Fatigue tests on 1 mm thick trapeze-shaped specimens of the AMg6 alloy show that vacuum testing atmosphere ( $10^{-4}$  Pa) prolongs the fatigue life by a factor of 6.2 and 4.3 at fatigue stresses of 300 and 200 MPa, respectively. Similar increases were observed in the numbers of fatigue cycles that result in crack nucleation. Microhardness increase due to fatigue cycling was found to be smaller in vacuum than in air. At a given number of fatigue cycles, testing in vacuum results in a smaller dislocation density and a smaller tendency for piling up of dislocations than testing in air. Figures 5; Tables 2; References 17: 13 Russian, 4 Western.

UDC 669.24.669.25

**Martensite Characteristics in Titanium Nickelide Alloys**

907D0159D Kiev METALLOFIZIKA in Russian  
Vol 12 No 3, May-Jun 90 pp 122-123

[Article by M.I. Zakharova and G.N. Kokoyev, Moscow State University]

[Abstract] Martensite characteristics of single crystals of  $\text{Ti}_{50}\text{Ni}_{46}\text{Mo}_4$ ,  $\text{Ti}_{46}\text{Ni}_{50}\text{Cr}_4$ ,  $\text{Ti}_{46}\text{Ni}_{50}\text{Ta}_4$ ,  $\text{Ti}_{48}\text{Ni}_{48}\text{Ta}_4$ , and  $\text{Ti}_{46}\text{Ni}_{50}\text{In}_4$  alloys were studied by X-ray diffraction after quenching from 1173 K and aging at 623 K. The martensite transformation temperatures of these alloys were determined during cooling from room temperature. After quenching, the  $\text{Ti}_{48}\text{Ni}_{50}\text{Ta}_4$  alloy consisted of a B2 BCC-solid solution and B19' monoclinic martensite. The remaining alloys were single-phase B2-solid solutions. Mo was found to reduce the B2-to-B19' transformation temperature by 97 K. Ti suppresses the B2-to-R martensite transformation, which is restored by aging and the accompanying reduction of the Ni content of the B2 matrix. Addition of Ta introduces a hysteresis of  $52^\circ$  into the B2-to-B19' and reverse transformations. Martensite transformation is completely suppressed by addition of In. Tables 1; References 4: 2 Russian, 2 Western.

UDC 539.2;532.62

**Anomalous Penetration of Molten Gallium Into Polycrystalline Aluminum***907D0159E Kiev METALLOFIZIKA in Russian  
Vol 12 No 3, May-Jun 90 pp 127-129*

[Article by L.N. Larikov, M.A. Vasilyev, I.N. Makeyeva, and V.I. Franchuk Metal-Physics Institute, Kiev]

[Abstract] A study of concentration profiles of gallium in aluminum and of structure changes in aluminum resulting from interaction with gallium is reported. Thin layers of gallium were applied on one end-face of 7 mm in diameter, 50 mm long specimens, some of which were previously recrystallized for 1 h at 573 K, and gallium was allowed to diffuse for 1 h at 301 K. Then the specimens were cut into 2.5 - 3 mm thick discs for surface determination of gallium and aluminum, X-ray diffraction study, and microhardness measurement. The gallium concentration curves for recrystallized and non-recrystallized specimens show a steep drop from the end-face to the depth of about 5 mm and then an anomalous segment in which the gallium concentration rises and then falls again. This anomaly is attributed to recrystallization processes that occur during the diffusion of gallium. Structure and texture changes that occur during the diffusion of gallium in recrystallized and nonrecrystallized specimens are described. Figure 1; References 15: 6 Russian, 9 Western.

UDC 539.4.001:678.067

**Laminated Composite Material Fracture Under Surface Impact***907D0170B Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 225-230*

[Article by V. V. Bolotin, A. A. Grishko, V. N. Shchugorev, Moscow Energy Institute and Machine Science Institute imeni A. A. Blagonravov at the USSR Academy of Sciences, Moscow]

[Abstract] The fracture of laminated composites under a surface impact is examined allowing for the substantial inhomogeneity and considerably nonlinear properties of the composites which are partly due to the microscopic damages scattered in the composite. The interaction of deformation waves with both layer boundaries and free boundaries, formed as a result of impact fracture, are taken into account. An analysis of a unidimensional model problem of a laminated regularly structured material medium capable of plastic deformation, accumulation of microdefects, and fracture by tearing made it possible to carry out a qualitative study of the phenomena accompanying the fracture of laminated composites under impact. The contribution of secondary deformation waves, forming as a result of reflection from the layer boundary and composite cracking, is estimated. References 15: 13 Russian, 2 Western; figures 5.

UDC 669.71.5'884

### Aluminum-Lithium Alloys for Engineering Purposes

907D0164A Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 4, Apr 90 pp 2-8

[Article by I.N. Fridlyander]

[Abstract] A literature-based discussion of the composition, properties, heat treatment, mechanical working, welding, and uses of aluminum-lithium alloys 1420, 1429 (PM alloy), 1421, 1423, 1430, 1440, and 1450 is presented. These alloys are distinguished by their low density (about 2.5 g/cm<sup>3</sup>), high strength (0.2% offset yield strength as high as 450 N/mm<sup>2</sup> and ultimate tensile strength as high as 540 N/mm<sup>2</sup>), high resistance to crack propagation, high fatigue resistance, good corrosion resistance, and good workability (alloys 1420, 1421, and 1423 are weldable). This makes them suitable for applications requiring a high strength-to weight ratio, such as in vertical-takeoff aircraft. The alloys contain about 2 percent Li. Their properties are modified by addition of up to 5 percent Mg, up to 3 percent Cu, and microquantities of Zr, Sc, Y, Ce, Ti and Be. Figures 8; Tables 13; References 5 Russian.

UDC 669.14.018.298:621.785

### Cost-Effectively Alloyed Steels For Very Large Forgings

907D0164B Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 4, Apr 90 pp 9-12

[Article by A.M. Vasilenko, M.A. Gervasyev, V.G. Sorokin, and V.T. Alekseyenko, TsVISHM (not further identified) and NKMZ Production Association]

[Abstract] To lower the consumption of nickel and molybdenum in heavy-forging steels, steels 35Kh2N2M (approx. % comp. 0.4 C, 0.3 Si, 0.4 Mn, 2 Cr, 1.6 Ni, 0.33 Mo) and 35Kh2N2MF (same as above but also ctg. 0.12 V) were tested as substitutes for steels 4KhN3M (0.4 C, 0.4 Si, 0.4 Mn, 0.9 Cr, 3 Ni, and 0.35 Mo) and 35KhN1M2FA (0.4 C, 0.3 Si, 0.45 Mn, 1.5 Cr, 1.5 Ni, 0.5 Mo, and 0.13 V). CCT curves for decomposition of supercooled austenite were prepared for 14 x 14 mm bars of the above steels for cooling rates between 1 and 50°C/min to determine their hardenability and to identify the martensite and bainite regions. Also, heat treatment that simulates the temperature changes at various depths of forgings and gives the microstructures that are produced at these depths in heavy forgings was carried out. This information, combined with calculations of temperature fields in 1000 mm forgings leads to the conclusion that 1000 mm forgings of steel 35Kh2N2M are through-hardenable by quenching in oil and have mechanical properties, including cold resistance, equal

to or exceeding those of steel 34KhN3M. The conclusion is confirmed by testing a 1000 mm forging of steel 35Kh2N2M. Figures 3; Tables 3; References 7 Russian.

UDC 621.785.796:14.018.29

### Effect of Intensity of High-Temperature Tempering on the Mechanical Properties of Machine-Building Steel Microalloyed With Nitrogen and Vanadium

907D0164C Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 4, Apr 90 pp 24-26

[Article by Ye. G. Aftandilyants and Yu. Z. Babaskin, Institute for Casting Problems]

[Abstract] The effect of tempering time between 5 and 180 minutes and temperature between 650 and 700°C on the mechanical properties of a steel containing (in percent) about 0.21 C, 1 Si, 2 Mn, 0.1 Mo, 0.005 S, 0.005 P, 0.01 O, and 0.05 V (steel 25G2SAFL) was determined and compared to the effect of these factors on a steel of the same composition but without vanadium (steel 25G2SL). The mechanical properties obtained in this manner are reported in a table together with the values of the Holloman's tempering parameter (tempering intensity) calculated for every set of tempering time and temperature. It was found that as the tempering temperature increases, the maximum hardness is obtained faster and the completion of precipitation of vanadium carbides requires less time. The best combination of strength ( $\sigma_B = 840$  N/mm<sup>2</sup>), elongation (23.8 percent), and area reduction (65 percent) for the vanadium-containing steel was obtained by tempering for 90 minutes at 650°C (tempering parameter between 18,600 and 19,000). The maximum impact toughness was obtained after 43 minutes at 675°C (tempering parameter 18,823). Figures 2; Tables 1.

UDC 669.15-196:620.178:621.78

### Effect of Combination Hardening on the Structure and Properties of High-Strength Cast Iron

907D0164D Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 4, Apr 90 pp 33-35

[Article by V.V. Belozarov, V.A. Guyva, A.I. Makhatilova, A.V. Radzivonchik, and M.L. Turovskiy, Kharkov Polytechnic Institute and Plant imeni Malyshev Production Association]

[Abstract] High-strength pearlitic cast iron containing (in percent) 3.7 C, 1.3 Mn, 2.1 Si, 0.05 P, 0.01 S, 0.04 Cr, 0.11 Ni, and 0.07 Mn was hardened by irradiation with a continuous 1.5 kW CO<sub>2</sub> laser to a depth of 0.5 mm, by work-hardening with a three-roller device pressed with a force of 1000 N, and by combination of the two methods. Laser treatment alone doubles the wear resistance but

reduces the fatigue endurance limit. Work hardening alone does not significantly increase the fatigue resistance. The combination treatment increases the fatigue endurance limit by 43 percent compared to the initial condition and by 185 percent compared to the laser-hardened condition. The increases in wear resistance and fatigue-endurance limit are explained in terms of the phase transformations and tensile and compressive stresses induced by laser treatment and work-hardening. Figures 3; Tables 1; References 6 Russian.

UDC 669.15'26-196:620.178.16

### **Mechanism of Hardening of Surface Layers by Impact and Abrasive Wear of High-Chromium Cast Iron**

9070164E Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 4, Apr 90 pp 35-36

[Article by O.S. Komarov, V.V. Ivashkin, and N.I. Urbanovich, Belorussian Polytechnic Institute]

[Abstract] Air-quenching from 1150°C of shot-blasting impeller blades made from high-chromium cast iron ICh270Kh18 followed by low-temperature tempering results in increased wear resistance of these blades. X-ray, metallographic, and electron-microscope studies were carried out to determine the cause of the increased wear resistance by layer-wise determination of the quantity of austenite and martensite and microhardness measurements. Thin layers were removed electrolytically. It was found that the increased wear resistance is caused by strain-induced transformation of austenite to martensite upon impact of the shot against the blades (which decreases the austenite content from about 65 percent to about 35 percent with a corresponding increase of the martensite content), work-hardening of austenite and martensite, and rolling of carbides into austenite undergoing plastic flow, thus hindering their erosion from the surface. The hardened layer is about 50 microns thick. Figures 2; Tables 1.

UDC 621.785.52.062:669.14.018.298

### **Mechanical Properties of Steels After Vacuum and Gas Case-Carburizing**

907D0165A Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 5, May 90 pp 10-12

[Article by A.G. Goncharov and R.P. Uvarova]

[Abstract] Specimens of machine-construction steels 20Kh, 18KhGT, and 12KhNZA and gearwheels of steel 25KhGT were vacuum case-carburized in methane at 1050°C and nonisothermally at 1100 - 1250°C, as well as

at atmospheric pressure of 920 - 950°C in cracked-hydrocarbon atmosphere, to produce a case depth of 1 - 3 mm. This was followed by reheating, quenching, and tempering for two hours at 180°C, and determination of mechanical properties. To determine the effect of carburization temperatures on the mechanical properties of the specimen cores, test specimens were also heated at carburizing temperatures without carburizing atmospheres for lengths of time necessary to produce a case depth of 2 mm. Compared to gas carburizing, vacuum carburizing has no adverse effect on the surface and core hardness and on the tensile and impact properties, except for a 6.7 percent impact toughness decrease of the core of steel 20Kh. Vacuum carburizing produces the same fatigue resistance of gear teeth as gas carburizing. Vacuum carburizing requires much less time than gas carburizing to produce the same case depth. Figure 1; Tables 3; References 11: 10 Russian, 1 Chinese.

UDC 621.785.533

### **Features of Saturation of Steels in High-Temperature Carbonitriding**

907D0165B Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 5, Mar 90 pp 18-19

[Article by S.A. Pegisheva, V.I. Nepogodin, I.A. Lobachev, I.V. Kirnos, S.T. Klyshnikov, and L.N. Golovin, VNIIT-MASH Scientific and Production Association, VNIIMT (All-Union Scientific-Research Institute for Metallurgical Heating Technology), and URALENERGOCHERMET Production and Technology Enterprise, Sverdlovsk]

[Abstract] Carbonitriding experiments with 50-micron foils at 930°C show that the solubility of carbonitrides in steel depends not only on the sum of the concentrations of carbon and nitrogen but also on the carbon content of steel. The solubility increases as the carbon content decreases. Also, the nitrogen content decreases as the carbon content increases in the single-phase temperature region. The equilibrium content of nitrogen in steel was found to be proportional to the ratio of partial pressure of ammonia to the partial pressure of hydrogen raised to the  $\frac{2}{3}$  power in the furnace atmosphere. Comparison of the kinetics of carburization and carbonitriding of thin foils shows that the flow of carbon into steel increases with the carbon potential and the ammonia content of the furnace atmosphere and that the effect of increasing ammonia content is greater than the effect of increasing carbon potential. Figures 4; 1 Russian reference.

UDC 621.762:669.018.25

**Effect of Composition and Heat Treatment on the Properties of TiC-Steel Alloys**

907D0165C Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 5, May 90 pp 45-48

[Article by E.I. Repina, I.N. Chaporova, and Z.V. Nikitina, VNIITS (All-Union Scientific-Research and Design Institute of High-Melting Metals and Hard Alloys)]

[Abstract] Sintered powder compacts containing 0.1, 10, 40, and 50 percent of TiC in a matrix containing 7% Cr, 2% Cu, 5% Mo, and 0.6% Si and steel powder compacts of the above matrix composition and containing 0.2 to 1.25 percent C were annealed for 2 h at 820°C in order to spheroidize eutectoid carbides, quenched to obtain martensite, and tempered at 150 to 600°C. The Rockwell and Vickers hardness and the bending strength of these steels and TiC-steel alloys were determined after annealing, after quenching, and after tempering. The Rockwell hardness of the steels after quenching and after tempering at 150 and 480°C was found to increase monotonically with carbon content. It is highest in the quenched condition and lowest after tempering at 480°C. The bending strength of the steels after quenching and after tempering at 150 and 480°C increases with carbon content to a maximum at about 0.45 percent C and then falls off. The highest and the lowest bending strength was obtained, respectively, after tempering at 150°C and after quenching. The Rockwell hardness and the bending strength of the alloys containing 10 percent TiC shows a variation with heat treatment and carbon content similar to that of the steels. The Rockwell hardness of the alloys containing 50 percent TiC after annealing, after quenching, and after tempering at 150, 480, and 600°C increases monotonically with carbon content, but not as rapidly as that of the steels. It is highest in the quenched condition and lowest in the annealed condition, and it decreases with the tempering temperature. The bending strength of the alloys containing 50 percent TiC after tempering at 150, 480, and 600°C increases to a maximum at 8.8 percent C and then falls off, the largest bending strength decrease occurring after tempering at 600°C. The microhardness of the steels and the alloy containing 10 percent TiC decreases monotonically with increasing tempering temperature. The Vickers hardness of the alloys containing 40 and 50 percent TiC shows almost no change with tempering temperature up to about 500°C and falls off sharply after tempering at 600°C. The variations of the mechanical properties are explained in terms of microstructure changes and carbide constituents. Figures 6; References 9: 6 Russian, 2 Western, 1 Czech.

UDC 669.259:620.191

**Effect of Thermomechanical Treatment on the Cracking Resistance of Titanium Alloys**

907D0165D Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 5, May 90 pp 49-50

[Article by Ye.B. Yegorov and M.Kh. Shorshorov, IMET (Metallurgy Institute imeni A.A. Baykov)]

[Abstract] An analytical literature review shows that crack resistance of two-phase ( $\alpha + \beta$ ) titanium alloys can be increased by polygonization of dislocation structure fixed by quenching from the deformation temperature. The best sequence of mechanical working and heat treatment steps aimed at achieving it and at the same time obtaining the maximum strength consists of straining in the lower part of the  $\beta$  region, superplastic deformation, quenching from the deformation temperature, and aging. Figure 1; References 6: 5 Russian, 1 Western.

UDC 669.15'26-194-155

**Improving the Carburizing Uniformity of High-Chromium Steels**

907D0167A Moscow IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: CHERNAYA  
METALLURGIYA in Russian No 4, Apr 90 pp 71-72

[Article by V. S. Popov, N. N. Brykov, M. I. Andrushenko, and I. V. Bryndin]

[Abstract] The possibility of attaining a high carbide phase concentration in a carburized layer of high-chromium low-carbon steels for use in rapidly-wearing parts was examined. Steels 08Kh13, 12Kh13, and 20Kh13 were tested. Samples were carburized for 5 - 14 h in a standard charcoal carburizer with an addition of 10 - 15 percent soda ash or 8 - 10 percent sodium acetate at 950 - 1080°C. It was established that steel 20Kh13 is the most suitable for refractory mold liners. Initial problems encountered in carburizing steel with a high chromium content, i.e., the development of a dense passive chromium oxide film on the surface, the low carbon diffusion rate, and the carburized layer's strong tendency to nonuniformity, have been overcome by using the proposed carburizing compositions and methods. Carburizing without a direct contact between the part and the carburizing agents makes it possible to obtain a uniform carburized layer and prevents the development of a carbide skin. Optimal amounts of carburizing agents and treatment conditions for steel 20Kh13, making it possible to improve its wear resistance three- to fivefold over steel 20Kh, were determined. Figures 1.

UDC 669.187.58.001.5

**On the Issue of Forming Eutectic Structure in Cr-Ti-C Alloy Smelted in Plasma Arc Furnaces***907D0157E Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 2, Apr-Jun 90 pp 71-77*

[Article by A Yu. Vlasenko, O. S. Zabarilo, A. F. Manulik, Electric Welding Institute imeni Ye. O. Paton, Kiev]

[Abstract] Examinations of the quality and properties of metal castings showed that, with respect to physical and mechanical properties, Cr-Ti-C eutectic alloys meet the requirements imposed on dies and forging tools but have axial porosity and shrinkage cavities extending more than  $\frac{2}{3}$  of the casting height. The task of obtaining uniform castings with a mass over 25 kg and a diameter of over 100 mm with the maximum eutectic content is very urgent. Consequently, attempts were made to simulate and describe the processes occurring during the plasma arc autocrucible smelting of the Cr-Ti-C eutectic alloy. Alloys smelted in an upgraded U-467 plasma arc furnace were examined by a metallographic analysis. A two-component charge was used for smelting. The results showed that in order to obtain uniform high-quality castings from the Cr-Ti-C eutectic alloy in plasma arc furnaces, it is necessary to ensure the maximum alloy component melting, dissolution, and diffusion rates, the maximum alloy composition blending rate, as well as to coordinate the alloy overlaying and crystallization rates. Figures 5; Tables 1; References 4: 3 Russian, 1 Western.

UDC 669.(293+295)

**Examination of Titanium-Niobium Alloy Obtained by Magnesium-Thermal Chloride Reduction***907D0158A Moscow TSVETNYYE METALLY in Russian No 5, May 90 pp 67-70*

[Article by P. G. Detkov, A. V. Chub, D. V. Drobot, A. A. Putin, V. V. Golikov]

[Abstract] A physical and chemical analysis of titanium-niobium alloys produced by concurrent magnesium-thermal reduction of niobium pentachloride mixtures with titanium tetrachloride was performed. MG-95 magnesium and OChT-0 titanium tetrachloride were used. Reduction was carried out in a retort made from steel 12Kh18N10T with an internal titanium liner to reduce the alloy contamination. Titanium-niobium sponges and pure titanium and niobium were produced. The homogeneity of the resulting sponges was examined. This analysis revealed that titanium sponges were highly homogeneous. It was established that following reduction, sponge samples consisted of a  $\alpha$ -face centered and  $\beta$ -body centered solid solutions of titanium. These

results attest to the possibility of producing titanium-niobium alloys with a high chemical and phase homogeneity by magnesium-thermal reduction. Figures 4; Tables 3; References 8.

UDC 537.317.62

**Microheterogeneity of Superconducting  $Y_1Ba_2Cu_3O_x$  Ceramics***907D0158B Moscow TSVETNYYE METALLY in Russian No 5, May 90 pp 77-79*

[Article by E. P. Bochkarev, A. F. Orlov, V. K. Tarasov, S. P. Kobeleva, I. F. Voloshin, V. V. Aleksandrov]

[Abstract] Despite the considerable interest in high-temperature superconductivity (VTSP) and numerous publications on the properties and composition of VTSP materials, the issue of the components microdistribution has not been adequately resolved. The content microdistribution in samples produced by various technologies was compared in order to establish a correlation between the resulting data and magnetic characteristics of the samples. Yttrium samples of the "123" composition with an almost 100 percent orthorhombic phase were subjected to an X-ray structural analysis. A statistical analysis of the resulting data did not reveal a noticeable correlation between the magnetic measurement results and the content of the main components. The results demonstrate considerable content heterogeneity of the principle phase and noticeable deviation from stoichiometry which, nevertheless, do not significantly affect magnetic characteristics. The effect of such process characteristics as the number of annealing cycles, roasting temperature and direction, oxygen concentration, and initial component ratio on the amount and composition of associated phase inclusions was established. The detected microstructure variations agree with available data on the quasi-ternary constitution diagram of  $Y_2O_3$ -BaO-CuO. Figures 1; Tables 1; References 3.

UDC 669.71.017:621.74

**Aluminum Alloys With Highly Heterogeneous Structure***907D0158C Moscow TSVETNYYE METALLY in Russian No 5, May 90 pp 91-94*

[Article by R. R. Malinovskiy]

[Abstract] Aluminum alloy casting with primary metal-ides and the possibility of obtaining atomized heterogeneous structures were examined. A two-stage alloy crystallization method with refractory metal additions and a metal-concrete process which makes it possible to obtain a cast structure with a high content of disperse intermetallic particles were developed. Aluminum alloys doped with Cr, Zr, W, Fe, Mn, and other elements were examined. Mechanical properties of aluminum alloys as a function of particle size, temperature conditions, and

matrix layer thickness were measured. It was discovered that the maximum strength of the alloys under study has not been attained and that their high-temperature strength can be subsequently increased by reducing the matrix layer thickness to a critical value by reducing intermetallide particles and increasing their volume content in the structure. I. T. Romanov and V. I. Tararyshkin participated in these experiments. Figures 3; Tables 1; References 5: 3 Russian, 2 Western.

UDC 669.71.5'884

### Structural Aluminum-Lithium Alloys

907D0166A Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 4, Apr 90 pp 2-8

[Article by I. N. Fridlyander]

[Abstract] Commercial applications of aluminum-lithium structural alloys since 1956 are reviewed. The composition and the results of comparative tests of alloys 1420, 1421, 1423, 1430, 1440, 1450, and 1460 are described. Their age hardening characteristics, corrosion resistance, and suitability for various types of welding, machining, and treatment are examined in detail. The ultimate rupture strength, toughness, ductility, resistance to repeat loading, endurance, crack resistance, notch sensitivity index, and other properties of extruded sections and panels, forged blanks, clad sheets, and other products are analyzed and compared. The possibility of developing laminated composite materials from alternating aluminum alloy and organic layers with a reduced density, greater strength, and a fatigue crack propagation rate lowered by almost tenfold for use in the aerospace industry is examined. Figures 8, Tables 13, References 5.

UDC 546.171.823'28

### Effect of Titanium on Phase Composition of Silicon Carbide

907D0176G Kiev POROSHKOVAYA  
METALLURGIYA in Russian No 5, May 90 pp 92-96

[Article by E.A. Palchevskiy, V.Ya. Bondars, and A.A. Kuzyukovich, Inorganic-Chemistry Institute, Latvian SSR Academy of Sciences]

[Abstract] The effect of the addition of titanium nitride powder to silicon nitride ( $\text{Si}_3\text{N}_4$ ) powder on the contents of the  $\alpha$  and  $\beta$  modifications and of the amorphous silicon nitride before and after heating the mixture for 4 hours in nitrogen at 1200 to 1650°C is reported. The nitride powder mixtures were synthesized by a previously described method and heated in a vacuum furnace filled with nitrogen at a pressure of 0.12 to 0.13 MPa. It was found that the addition of titanium results in increased synthesis of the  $\beta$  modification of silicon nitride and in crystallization of amorphous silicon nitride. The crystallinity of titanium-containing powders

increases with the titanium content and heat-treatment temperature. For example, 90 percent of amorphous silicon nitride crystallizes at 1300°C when the titanium content is 20 percent, and crystallization is practically complete at 1400°C even in the absence of titanium. Figures 5; Tables 1; References 9: 6 Russian, 3 Japanese (in Western periodicals).

UDC 669.295-122.4:620.186

### Conversion of Laminar Microstructure to Equiaxial Upon Hot Deformation of VT5-1 Titanium Alloy

907D0183A Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA METALLY in Russian  
No 3, May-Jun 90 pp 113-119

[Article by G. A. Salishchev, R. Ya. Lutfullin, and M. I. Mazurskiy, Sverdlovsk]

[Abstract] A study is made on the evolution of laminar microstructure upon hot deformation of titanium alloy type VT5-1. The chemical composition of the alloy was, in mass percent: Al - 5.4, Sn - 2.8, Zr - 0.01, O - 0.11, Fe - 0.03, Si - 0.01, H - 0.002. Specimens were vacuum annealed at 1040°C for 0.5 hr. Specimens were upset at 800 - 1100°C and  $5.5 \times 10^{-5}$  -  $5.5 \times 10^{-3} \text{ s}^{-1}$ . Some of the specimens were then cooled in water to room temperature in not over 1 s, others were held at the test temperature about 23 s. A more rapid transformation of the microstructure was observed after hot deformation due to the formation of acute-angle grain and phase boundaries and activation of diffusion and polymorphous  $\alpha \rightarrow \beta$  conversion. Figures 4, References 15: 11 Russian, 4 Western.

UDC 548.53

### Recrystallization of Metals by Electric Current

907D0183B Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA METALLY in Russian  
No 3, May-Jun 90 pp 120-122

[Article by V. F. Gordeyev, G. M. Kudinov, and A. V. Pustogarov, Moscow]

[Abstract] A study is made on the process of recrystallization of metals under the influence of electric current. Directed recrystallization occurs when a metal is heated to 80 or 90 percent of the melting point in  $10^2$  -  $10^3$  s. The orientation depends on the type of crystalline lattice. This nature of recrystallization is related to the preferential growth of grains with the crystallographic direction having the minimum resistivity. These grains have higher temperatures due to the anisotropy of heat liberation, and their growth is thermodynamically favored. The anisotropy of resistivity in cubic crystals with interstitial impurities results from anisotropic distribution of dislocations appearing under the influence of the current. References 11: Russian.

UDC 621.793.4

**Surface Alloying of Steel With Silicon, Nickel and Chromium**

907D0183C Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA METALLY in Russian  
No 3, May-Jun 90 pp 150-152

[Article by L. L. Stetsovskiy, A. I. Rogov, and L. A. Shvartsman, Moscow]

[Abstract] A comparative study is presented of four types of chemical-heat processing of steel: siliciding, siliconickeliding, silicochromiding and silicochromonickeliding. Siliciding or siliconickeliding forms a ferrite surface layer with a depth increasing in proportion to time, concentration of silicon and nickel in the layer 4 and 2 mass percent. Silicochromiding or silicochromonickeliding forms an austenitic surface layer, the kinetics of increasing depth of which are parabolic. The surface concentrations of chromium and nickel reach 20 and 13 mass percent. The silicochromided and silicochromonickelided layers, though not very thick, can, in certain cases, protect carbon steel from the effects of acid, increasing its corrosion resistance to that of stainless steel. Figures 2, References 10: 6 Russian, 4 Western.

UDC 669.295'296'782:539.213

**Structure of Amorphous Ti-Zr-Si Alloys**

907D0183D Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA METALLY in Russian  
No 3, May-Jun 90 pp 169-172

[Article by Ye. B. Rubina and O. B. Tarasova, Moscow]

[Abstract] Amorphous Ti-Zr-Si alloys are studied by differential thermal, electron-microscope and X-ray structural analysis. Studies were performed on

$Ti_{41}Zr_{41}Si_{18}$ ,  $Ti_{60}Zr_{22}Si_{18}$  and  $Ti_{70}Zr_{12}Si_{18}$  strips 45 - 55  $\mu m$  thick and 2 - 5 mm wide. Close order characteristics of the amorphous materials are determined. The close-order structure features contact between metal atoms with cavities filled with silicon atoms, with a coordination number close to 12, which does not contradict the possibility of existence of icosahedral close order structure or an order corresponding to a random close packing of the metal atoms. Figures 3, References 11: 7 Russian, 4 Western.

UDC 669.018.9

**Mechanical Properties of Ceremets in This System Titanium Nitride-Nickel Aluminide**

907D0183E Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA METALLY in Russian  
No 3, May-Jun 90 pp 184-186

[Article by A. V. Kuznetsov, S. M. Barinov, V. I. Kotenev, N. N. Mertsalova, and A. V. Kasimtsev, Moscow, Tula]

[Abstract] Studies are presented on the structure and temperature variation of mechanical properties of materials obtained by hot isostatic pressing of composite powders in the system  $TiN-Ni_3Al$  in the presence of the liquid phase. However, previous studies have stated that titanium nitride is not wet by nickel and aluminum, and therefore the materials were manufactured using composite powders produced by internal nitriding of the alloy powders in the system  $Ni-Al-Ti$ . Selecting the relationship of components in this system, nitriding conditions and subsequent processing yielded powders with variable content of  $TiN$  and dispersion of segregated nitride. The segregations can significantly increase hardness, strength and high-temperature ductility of the nickel aluminide. At 900°C, a material containing 25 percent  $TiN$  has a strength of 400 MPa, superior to the strength of cast alloys and powder materials based on  $Ni_3Al$ . Figures 2, References 10: Russian.



UDC 666.233:54-44.022.61

**On the Issue of Increasing Catalyst Reactivity for Diamond Synthesis**

907D0156H Moscow FIZIKA I KHIMIYA  
OBRABOTKI MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 122-126

[Article by V. Ya. Slobodskoy, V. V. Sobolev, S. I. Gubenko, A. A. Udoyev, Dnepropetrovsk]

[Abstract] The possibility of increasing catalyst reactivity by creating conditions for the formation of occluded gas (pores) was examined. The pores develop an extended working surface network and accelerate diamond synthesis which occurs on the graphite-catalyst interface. The method of producing catalyst by crystallizing the melt on a horizontally rotating heat-removing plane makes it possible to increase catalyst reactivity for diamond synthesis by creating conditions for gas pocket formation. This method makes it possible to control catalyst reactivity within a broader range than with other methods. Figures 2; Tables 2; References 1.

UDC 541.64:539.2

**Stability of Partially Flexible Molecule System Under Pressure**

907D0180A Moscow KRISTALLOGRAFIYA  
in Russian Vol 35 No 2, Mar-Apr 90 pp 289-297

[Article by V. K. Pershin and V. A. Kanoplev, Urals Polytechnical Institute]

[Abstract] A study was conducted on a model of a molecular system which describes the orientation ordering and conformational flexibility of particles, and problems are solved related to the influence of external pressure on phase and structural behavior. A phase diagram of the system is constructed in coordinates of length versus flexibility of the particles. The response of the system of conformationally flexible and rigid molecules to external mechanical action is significantly different. This indicates that in the intermediate case for systems of partially flexible molecules there should be a clear variation with the degree of conformational flexibility of liquid crystal particles. A mechanism is suggested for suppression of the conformational phase transition with increasing external pressure. New elements in the variation of the orientation order parameter with pressure at fixed temperature are described. The results obtained are compared with experimental data for liquid crystals and homologous series of paraffins. Figures 6, References 14: 3 Russian, 11 Western.

UDC 548.736.4

**Influence of Simultaneous Reflections on Intensity of Diffraction Reflexes From Single Crystals**

907D0180B Moscow KRISTALLOGRAFIYA in Russian  
Vol 35 No 2, Mar-Apr 90 pp 303-306

[Article by N. B. Bolotina, T. S. Chernaya, and A. M. Golubev, Institute of Crystallography, USSR Academy of Sciences]

[Abstract] A mathematical apparatus is presented for numerical estimation of distortions of measured intensities in precision X-ray diffraction experiments. The influence of the effect of simultaneous reflections on the intensity of reflexes from single crystals is analyzed. A method is suggested for quantitative estimation of the corresponding distortions in measured intensities. Software programs were developed to minimize the influence of simultaneous reflections on the results of structural analysis. Various modifications of the programs are required, depending on whether processing is performed before, during or after experiments. The post experimental processing method was tested, in which for each measured reflex the program determines simultaneous reflexes and estimates possible distortion of the measured intensity. Figure 1, References 11: 2 Russian, 9 Western.

UDC 548.736.6

**Synthesis of New  $\text{Ga}_{0.5}\text{In}_{1.5}\text{S}_3$  Semiconductor With Predefined Structure**

907D0180C Moscow KRISTALLOGRAFIYA  
in Russian Vol 35 No 2, Mar-Apr 90 pp 332-336

[Article by I. R. Amiraslanov, F. Yu. Asadov, B. A. Maksimov, V. N. Molchanov, A. A. Musayev, and N. G. Furmanov, Institute of Physics, Azerb Academy of Sciences]

[Abstract] A search is conducted for a compound in the class of mixed-layer structures satisfying a proposed hypothetical model with a predefined relationship of packets. The specifics of the atomic structure of the compounds in the space between packets is determined. The structure of the crystal is constructed of two types of packets: a two-level packet formed of the densest packing of indium-type octahedrons and a four-level packet containing a central layer of densely packed In octahedrons and two outer layers of tetrahedrons populated with Ga and In atoms statistically. The alternating two- and four-level packets are in a ratio of 1:2. Figures 2, References 12: 9 Russian, 3 Western.

UDC 548.736.6

**Crystalline Structure of New Natural (Ba, Nb) Silicate***907D0180D Moscow KRISTALLOGRAFIYA  
in Russian Vol 35 No 2, Mar-Apr 90 pp 346-348*

[Article by N. A. Yamnova, D. Yu. Pushcharovskiy, and A. V. Voloshin, Moscow State University imeni M. V. Lomonosov]

[Abstract] A new Ba silicate-niobate has been established in carbonatites from the Kola Peninsula. Chemical analysis has indicated the formula of the mineral is  $\text{Ba}_3\text{TiNb}_4\text{Si}_4\text{O}_{23}$ , indicating its similarity to two previously known forms of synthetic crystals: reduced  $\text{Ba}_3\text{Si}_4\text{Ta}_6\text{O}_{23}$  and oxidized  $\text{Ba}_3\text{Si}_4\text{Ta}_6\text{O}_{26}$ , as well as  $\text{Ba}_3\text{Si}_4\text{Nb}_6\text{O}_{26}$ . This article presents a comparative crystal-chemical analysis of these natural and synthetic minerals. The new mineral has 166 reflexes, crystallographic parameters  $a = 9.03(1)$ ,  $c = 7.868(6)$  Å,  $Z = 1$ , n.b.P62m. A mixed frame of octahedral columns with triangular cross section connected by diorthogroups is found with Ba atoms in the cavities. Figure 1, References 9: 2 Russian, 7 Western.

UDC 666.16:629.113.011.671:621.9.025.7

**Diamond Tool for Working Thin Motor-Vehicle Glass***907D0181A Moscow STEKLO I KERAMIKA  
in Russian No 4, Apr 90 pp 8-9*

[Article by V. R. Kangun and G. M. Sverdlov, Scientific-Production Association of All-Union Scientific Research Institute of Diamonds]

[Abstract] The glass plant imeni M. Gor'kiy is now producing thin motor-vehicle glass 3.2 mm thick for the new generation of automobiles. The authors' association has developed and introduced two production type 2F6V diamond disks ( $R = 1.6$  mm) for working of this glass in automatic mode, requiring disks with increased cutting ability to reduce the load on the glass blank and to improve reliability and operating life. The cutting portion of the tool has a new design in which the diamond layer becomes thicker from the edge toward the center to compensate for manufacturing errors. The cutting ability of the diamond tools can be increased by increasing the strength of the diamonds and improving their shape, increasing the attachment of individual grains in the binder, improving the properties of the binder and refining the design of the tool. The metallic binder contains alkali-metal fluorides, finely dispersed nickel and chromium. Tests of this new type M3-05 binder in tools with stronger diamonds indicated that tool life was improved. Figures 3.

UDC 666.11.01:620.193.41

**Water Resistance of Multicomponent Glasses***907D0181B Moscow STEKLO I KERAMIKA  
in Russian No 4, Apr 90 pp 9-10*

[Article by P. I. Buler, L. G. Protasova, I. G. Kosnyreva, and Ye. V. Turaykina, Urals Polytechnical Institute imeni S. M. Kirov]

[Abstract] A study is made on the water resistance of  $\text{SiO}_2 - \text{B}_2\text{O}_3 - \text{Na}_2\text{O}$  glasses with constant component ratio 1:0.54:0.49. Additives of  $\text{Li}_2\text{O}$ ,  $\text{CaF}_2$ ,  $\text{FeO}$ ,  $\text{CuO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{MnO}$ ,  $\text{MgO}$ ,  $\text{CaO}$ ,  $\text{Al}_2\text{O}_3$  and  $\text{ZnO}$  were tested, retaining the same ratios of components. The glasses were made in corundum crucibles at 1373 - 1573 K. The melt was granulated in water and a glass charge of 1 g ground to a mean diameter of 0.5 - 0.8 mm was placed in a flask of distilled water and boiled for one hour with reflux cooling, then the mass loss was determined. Water resistance did not always correlate with the quantity of alkaline sodium present, due to the simultaneous occurrence of two processes: leaching of individual structural groups and ion exchange between  $\text{Na}^+$  and  $\text{H}^+$ . Whereas ion exchange predominated in the interaction of the glass with water, the quantity of sodium ions going over into solutions did not correlate with the water resistance of the glass determined by its mass loss. Water resistance of multicomponent glasses depends primarily on the quantity of leached structural groups containing sodium ions. Figure 1, References 2: Russian.

UDC 666.1.011:539.3

**Effective Design of High-Strength Structures With Viewing Windows***907D0181C Moscow STEKLO I KERAMIKA  
in Russian No 4, Apr 90 pp 11-12*

[Article by E. A. Abramyan and I. I. Dyachkov, Institute of Strength Problems, Ukrainian Academy of Sciences]

[Abstract] By considering the stress-strain state of glass, viewing windows as high-strength products containing such windows are designed, it is possible to design these products in order to maximize the effective utilization of the potential strength of the glass. This article presents an estimate of the structural strength of a viewing window with a disk-shaped glass element made of inorganic glass, and it presents a comparative analysis of the stress-strain state of viewing windows of identical size but different design, and determines the maximum load-bearing capacity, operating life and durability of highly stressed viewing units. A promising design for an independent viewing window is developed, eliminating all direct contact between the glass and the metal structure by the use and proper placement of elastic rings. The limiting load-

bearing capacity of the viewing window when briefly loaded by hydrostatic pressure is a function of the ratio of thickness to diameter of the flat disk glass element. The optimal ratio is 0.52 for MKR-1 and K8 glass elements. Figures 4, References 2: Russian.

UDC 666.593

#### **Production of Tubular and Rod Electroceramics**

907D0181D Moscow STEKLO I KERAMIKA  
in Russian No 4, Apr 90 pp 13-14

[Article by B. I. Gaydash, V. A. Aleko, K. N. Logvinov, M. B. Lebedev, and A. Ya. Mishchenko, All-Union Scientific Research Institute of Electroceramics, "Elektrofarfor" Scientific-Production Association]

[Abstract] The authors institute has developed, manufactured and introduced automated lines for the production of electroceramic beads, tubes and rods to a number of ceramics plants. The line consists of a vacuum press, installation for placement and cutting of blanks, dryer, conveyor for receiving the dried products and a control cabinet. The operation of the line is briefly described and diagrammed. The economic effect achieved by introduction of one such line is no less than 50,000 rubles per year. Figures 4.

UDC 666.65-12

#### **Influence of Glass and Crystal Phase Content on Conductivity of Ceramic Materials**

907D0181E Moscow STEKLO I KERAMIKA  
in Russian No 4, Apr 90 pp 19-20

[Article by N. P. Antonova, O. G. Gorodetskaya, N. P. Grevtsova, N. N. Yermolenko, A. G. Kirin, M. I. Muminov, Yu. S. Skripnikov, V. N. Sandalov, and F. Ya. Kharitonov, "Elektrofarfor" Scientific-Production Association, Belorussian Polytechnical Institute, Institute of Nuclear Physics, Uzbek Academy of Sciences]

[Abstract] A study was made of specially synthesized ceramic materials with various ratios of crystal and glass phases. The glass phase was modified by replacing  $\text{SiO}_2$  by  $\text{ZrO}_2$  up to 3 percent to increase resistivity and improve physical-mechanical properties and alkali resistance. The materials obtained were used to manufacture ceramic materials containing 10, 25 and 40 percent glass. X-ray diffraction and electron-microscope studies of these materials were performed. Conductivity increased, while activation energy of ions involved in conductivity decreased with increasing phase interface and were thus found to be functions of the dispersion of the material and the quantity of the crystal phase present. Figures 2, References 5: Russian.

UDC 666.151.658.562

#### **Surface Quality of Heat-Polished Glass**

907D0182A Moscow STEKLO I KERAMIKA  
in Russian No 5, May 90 pp 9-11

[Article by V. N. Menshov and N. A. Pankova, Kiev Specialized Enterprise, All-Union "Soyuzavtomatstrom" Scientific-Production Association, State Scientific Research Institute of Glass]

[Abstract] A study is made on the change in surface quality of heat-polished glass by means of laser interferometry in order to develop methods for continuous process testing of the quality of glass strip in terms of flatness and optical defects. The studies were performed by interferometric determination of variations in optical thickness by means of the new IKF-L and IKF-T scanning interferometers, which can perform quantitative and qualitative studies of optical heterogeneities in glass strips. The basic optical distortions in heat-polished glass were found to be related to four types of fluctuations in optical thickness, differing in periodicity and amplitude. All of these distortions can be monitored by scanning with the new interferometers. Television cameras can be used for process monitoring of optical defects in the manufacturing process of the glass strips. Figures 4, References 5: 4 Russian, 1 Western.

UDC 666.263.2:539.4

#### **Synthesis of Heat- and Wear-Resistant Crystalline Glass Material**

907D0182B Moscow STEKLO I KERAMIKA  
in Russian No 5, May 90 pp 12-13

[Article by V. Yu. Goykhman, Ye. S. Orlova, L. T. Konik, and N. S. Naumenko, Scientific Research Institute of Automobile Glass]

[Abstract] The authors' institute has studied the possibility of using the production wastes of beneficiation plants for the production of glass and crystalline materials. The beneficiation wastes have stable chemical composition containing  $\text{SiO}_2$ ,  $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{FeO}$  and  $\text{Al}_2\text{O}_3$ . These wastes were used to synthesize pyroxene glass in the system  $\text{CaO-MgO-SiO}_2$ . The pyroxenes are distinguished by their good crystallization capacity and superior physical-chemical properties of the crystalline material produced. The properties of the glasses produced were judged satisfactory. The glass was made at 1450 - 1480°C, crystallization was performed at a maximum temperature of 900°C. Introduction of iron ore plus heat treatment forms a fine-crystalline pyroxene structure. Introduction of chromium-containing wastes yields a crystalline glass material containing pyroxene which can be identified with augite. Chromium with a high content of aluminum and iron stimulates crystallization and is included in the augite formed. The material can be used to protect or replace metal in the coal, cement, chemical, power and other industries. The economic effect of production of crystalline glass materials from coal beneficiation wastes is 2.2 million rubles, yielding a savings of about 70,000 tons per year of metal with an output of 20,400 tons per year.

UDC 666.7:546.273

**Boron-Containing Construction Ceramic for Neutron Radiation Protection***907D0182C Moscow STEKLO I KERAMIKA  
in Russian No 5, May 90 pp 17-19*

[Article by V. P. Tarasevich, L. B. Isayeva, Ye. V. Kuznetsov, and I. A. Zhenzhurist, All-Union Scientific-Production Association for Wall, Binder Materials, Kazan Institute of Chemical Technology]

[Abstract] Information is presented on the creation of a new formula for a boron-containing structural ceramic

modified with powder from rolling of batolite ore, danburite ore and boron-magnesium slime waste from beneficiation of borate-magnetite ore. Addition of 5 - 15 percent additives was found to be optimal, significantly improving the strength characteristics and decreasing water absorption of specimens. Frost resistance of all specimens was over 50 cycles. Use of the new compositions of ceramics is recommended for the production of facing and lining structural materials and products to provide protection from neutron bombardment. A new process manufactured of bricks has been recommended (but is not described here), while the traditional slit methods are recommended for the manufacture of ceramic plates. Figures 2, References 3: Russian.

UDC 621.762

**Molding and Sintering Peculiarities of Highly Disperse Refractory Metal Powders**

907D0156G Moscow FIZIKA I KHIMIYA  
OBRABOTKI MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 117-121

[Article by R. U. Kalamazov, Yu. V. Tsvetkov, N. K. Aleksandrova, A. T. Ibragimov, A. M. Kruchinin, Moscow]

[Abstract] Molding of highly disperse tungsten and molybdenum powders was examined during single-action compaction in rigid molds of various types and dimensions as well as during rapid powder loading inside elastic shells. Original highly disperse powders, their mixtures with standard powders, and granulated powders were used in these experiments. Powders were granulated using a vibration mixer by adding various high-molecular compounds to the powder. An experimental analysis of the sintering of highly disperse molded powders shows that the sintering kinetics largely depend on the particle state and size, surface conditions, and other factors. A comparative analysis of experimental data revealed significant differences in the established patterns which can be attributed to the recrystallization mechanism of sintering. It was shown that defect structure measurements taken by the electron-positron annihilation method make it possible to predict the necessary molding force. Figures 6; References 6.

UDC 669.187.56.002.2

**Pressure Electroslag Refining of Steels With Super-Equilibrium Nitrogen Content**

907D0157D Kiev PROBLEMY SPETSIALNOY  
ELEKTROMETALLURGII in Russian  
No 2, Apr-Jun 90 pp 42-48

[Article by K. A. Tsykulenko]

[Abstract] Nitrogen has increasingly been used as an alloying element in order to improve steel properties; nitrogen additions to iron alloys expand the austenite area and lower the martensite transformation temperature as well as favorably affect the strength, corrosion resistance, low-temperature creep, and high-temperature deformability. During electroslag refining, nitrogen must be supplied in the form of solid nitrogen-containing additions under an excess nitrogen pressure over the slag bath in order to retain nitrogen in the molten metal. Exceptional properties of and the broad outlook for austenite steels highly alloyed with nitrogen open up wide prospects for their use. Better strength characteristics, high cold working susceptibility, and increased corrosion resistance make these steels suitable for use as nonmagnetic materials in power engineering, as well as shipbuilding, cryogenics, chemical engineering, and pressure vessels. Research results obtained by the Batelle

Institute in the U.S. and Krupp, Vereinigte Schmidwerke, Inteco, and Leibold AG in West Germany are reviewed. Figures 3; Tables 1.

UDC 669.287.58.001.5

**On Using Induction Furnace Refining in a Sectional Mold for Reclaiming Platinum Alloy Byproducts**

907D0157F Kiev PROBLEMY SPETSIALNOY  
ELEKTROMETALLURGII in Russian  
No 2, Apr-Jun 90 pp 96-99

[Article by I. V. Sheyko, N. I. Timofeyev, V. A. Dmitriyev, Yu. V. Lisovoy, G. A. Vysotskiy, Electric Welding Institute imeni Ye. O. Paton, Kiev]

[Abstract] Due to platinum's insignificant affinity for oxygen and other aggressive gases, it can be refined and remelted many times. Yet when it is remelted in induction furnaces with a refractory crucible, the content of exogenic nonmetallic inclusions in the metal increases. The problem is even greater in refining platinum alloys due to the oxidation of alloying elements. Ingress of nonmetallic inclusions during the waste remelting can be avoided by using induction furnaces with cold crucibles or sectional molds. Such a unit was developed at the Paton Institute and put on-stream at one of the enterprises. A molten metal pool roughly equal to the mold diameter is built up with the help of an RF electromagnetic field; the sectional cooled mold is gradually charged with the mixture while the deposited ingot is gradually pulled from the induction heater. To protect the melt from the air, inert gas is delivered to the sectional mold. Thus, the results and experience of commercial operation of the induction heating plant with the sectional mold attest to the fact that such units can be effectively used to recover precious metal byproducts and precious metal alloys. Figures 3; Tables 1; References 2.

UDC 621.74.043

**Production of Large-Size Iron Castings in Metal Molds**

907D0160A Moscow LITEYNOYE PROIZVODSTVO  
in Russian No 4, Apr 90 pp 16-17

[Article by M. G. Shrage, Ya. B. Ayzenshteyn]

[Abstract] Production methods and equipment for making large-size 300 - 2,000 kg iron castings in metal molds were developed at the NIISL Scientific Production Association. They were developed to improve production space utilization and to shorten the process, technology, tooling, and equipment for making large-size iron castings with a horizontal parting line. A split metal mold consisting of a cope and a drag was used. Cast iron was smelted in an IChT-2.5 induction furnace. The cooling water was supplied immediately after pouring

the molten metal. The optimal chemical composition of the metal, the poured metal temperature, and the time variables of the process were determined. Analytical results show that this technology makes it possible to save 39,500 t of metal a year, free 16 workers, save 330 m<sup>2</sup> of production space, and save a total of 80,000 rubles a year. A. V. Yeliseyev, A. A. Belilovskiy, and S. A. Vodopyanova also contributed to this article.

UDC 621.744.37

### Protective Hardening Coat for Shell Molds

907D0160B Moscow LITEYNOYE PROIZVODSTVO  
in Russian No 4, Apr 90 p 17

[Article by Yu. P. Vasin, Yu. M. Itkin, A. N. Loginovskiy, A. N. Kopylov]

[Abstract] To improve the investment casting method (LVM) the last shell mold layer was replaced with a protective hardening coat based on synthetic resins whereby the pattern box, with dry refractory layers already applied to it, was dipped in synthetic resin without dusting; the resulting layer was then hardened in a liquid hardener. In so doing, easily available and inexpensive resins which are much cheaper than the refractory suspension were used. The KF-40 carbamide furan resin which is a light brown water-soluble liquid was used as the hardening coat. A 9 percent aqueous solution of hydrochloric acid was used as the hardener. The greater strength of the new molds compared to the traditional ones was attributed to their hardening due to the formation of a strong water repellent resin film which prevented the sogging of traditional layers and increased the mold resistance to expansion during the meltout. The increase in the mold strength at 900°C was attributed to the formation of a coke skeleton which traditionally bonded the dusting material grains in the preceding shell layers. The coke residue on the resin layer affected the casting surface quality. Thus, the use of new technology will make it possible to replace the last traditional refractory coat layer in LVM coats with a layer made of cheaper materials. This will also shorten the molding duration, increase mold strength, reduce losses, decrease casting rejects, and reduce the decarburized layer depth on the casting surface by 50 percent. The anticipated economic impact is 30 - 50 rubles per ton of usable castings. Figures 1; Tables 1.

UDC 621.74.002.6:669.131

### Improving Service Properties of Cast Iron With an Elevated Silicon Content

907D0160C Moscow LITEYNOYE PROIZVODSTVO  
in Russian No 4, Apr 90 p 26

[Article by V. N. Nepomnyashchiy, D. V. Golubev]

[Abstract] The structure and properties of silicon cast iron used for aluminum electrolyzer current lead elements were examined. This cast iron was smelted in an induction furnace with a basic lining using the LKO foundry pig iron, steel

St.3, and FS75 ferrosilicon as the mixture. Ground silicocalcium SK15 and ZhKM as well as dysprosium and scandium were added to the melt before casting as inoculants. Mechanical properties, specific resistance, and resistance to scaling were examined. The vermicular shape discovered in graphite was due to ZhKM additions; ZhKM inoculation also resulted in larger ledeburite inclusions than dysprosium inoculation. Moreover, ZhKM inoculated cast iron had the highest scaling resistance while scandium reduced electrical resistance the most. Thus, it is expedient to use ZhKM and scandium as inoculants for making silicon cast iron for electrolyzer contacts in order to improve the structure and performance under high temperature conditions and lower electric resistance. Tables 1.

UDC 621.74.002.6:621.318.1

### Chemical Alloy Composition Optimization and Permanent Magnet Casting Technology

907D0160D Moscow LITEYNOYE PROIZVODSTVO  
in Russian No 4, Apr 90 pp 26-27

[Article by I. O. Leushin, G. I. Timofeyev]

[Abstract] Magnetic parameters of the Fe-Ni-Al-based YuNTS alloy are determined by the specific features of its structure consisting of an iron-rich phase and a weakly magnetic NiAl intermetallic matrix with a low iron content. Excess aluminum negatively affects the magnetic texture and reduces the residual magnetic flux to unsatisfactory levels. The alloy's chemical composition and magnet casting technology were optimized by the simplex method. Casting cooling conditions after filling the molds were also examined. A fractographic analysis of heat treated castings cooled at various rates revealed that coarse-grained fracture castings had better magnetic properties, probably due to a greater probability of domain orientation along the external magnetization direction. Thus, chemical composition and magnet casting technology optimization made it possible to stabilize the magnetic texture of the castings, insure the necessary residual magnetic flux level, and completely eliminated rejects, resulting in a 7,200 ruble savings per ton of usable castings. V. V. Sorokoumov, V. V. Ramin, and A. M. Sherstnev also participated in this article.

UDC 621.762.214(088.8)

### Production Practice and Properties of Very Fine Nickel Powder

907D0176A Kiev POROSHKOVAYA  
METALLURGIYA in Russian No 5, May 90 pp 1-4

[Article by N. Ye. Kharitinych, T. I. Vizerina, A. P. Kaban, and V. I. Suprunchuk, Institute of Colloidal and Water Chemistry of the Ukrainian SSR Academy of Sciences, Kiev Polytechnic Institute, and Kiev Food-Industry Technology Institute]

[Abstract] Production of very fine nickel powder (pure and lyophilized with polycapramide for protection from oxidation) from nickel formate dihydrate is described. A 6:1 mixture of nickel formate and acetone or a 6:2:2 mixture of nickel formate, polycapramide, and acetone is homogenized in a reactor, heated to 80°C to expel acetone, to 150°C to expel water of hydration, and to 280°C to decompose nickel formate. The density of the powder increases with heating time. The specific surface area goes to a maximum and then falls off, and the particle size increases with heating time. The optimum heating time is 120 minutes for production of pure powder and 150 minutes for production of lyophilized powder. This results in a density of 8.381, a specific surface area of 5.6 m<sup>2</sup>/g, and a mean particle size of 2 to 5.5 μ in the case of pure powder and a density of 8.636, a specific surface area of 9.6 m<sup>2</sup>/g, and a mean particle size of 0.5 to 2.0 μ in the case of lyophilized powder. The pure and the lyophilized powders resist oxidation up to 305°C and 390°C, respectively. Figures 3; Tables 2; References: Russian 7.

UDC 621.762

#### **Compaction Kinetics of Covalent-Materials Powders in Hot Pressing**

907D0176B Kiev POROSHKOVAYA  
METALLURGIYA in Russian No 5, May 90 pp 19-24

[Article by M. S. Kovalchenko, Institute for Materials-Science Problems, Ukrainian SSR Academy of Sciences]

[Abstract] Haase's and Van Buren's models of compaction of powders controlled by acceleration of creep with time are used to derive kinetics equations for compaction of covalent materials such as germanium, silicon, and nonmetallic compounds such as boron carbide. It is shown that, unlike in the case of metal powders, the compaction rate for these materials decreases nonmonotonically with time and that the deceleration of compaction at early stages of hot pressing increases with increasing initial compaction. This knowledge can be used to determine the pressing time at which additional hot isostatic pressing of high-density covalently bonded materials requires an excessive length of time to achieve additional compaction. Figures 2; References 8: 7 Russian (3 translations of Western publications), 1 Western.

UDC 669.017.3

#### **Phase Transformations and Structure of Eutectic Cu-Sn-Ni and Cu-Sn-Ni-Cr Alloy Systems**

907D0176C Kiev POROSHKOVAYA  
METALLURGIYA in Russian No 5, May 90 pp 24-28

[Article by V. P. Chepeleva, L. M. Yupko, A. G. Mgebrova, and Ye. S. Cherepenina, Institute for Ultrahard Materials and Institute for Materials-Science Problems, Ukrainian SSR Academy of Sciences]

[Abstract] A method for optimizing low-melting compositions of tin-nickel bronzes alloyed with adhesion-active elements such as titanium, chromium, or vanadium for use as binders in tools made from ultrahard materials by powder metallurgy is presented. The method is used when quaternary constitutional diagrams are unknown. It consists of selecting eutectic Cu-Sn-Ni compositions from known diagrams, alloying them with an adhesion-active metal, and studying the phase composition of the resulting quaternary alloys. The optimum addition of the fourth element is determined from DTA data. The method is illustrated on the example of chromium as the fourth element. Two Cu-Sn-Ni near-eutectic compositions were alloyed with 8 and 48 at.% Cr, and their phase compositions were determined. It was found that chromium does not significantly change the structure or the phase-transformation temperature of the ternary alloys, does not form intermetallic compounds, and dissolves only slightly in the phases of the Cu-Sn-Ni eutectics [α(Cu, Ni) and (Cu, Ni)<sub>3</sub>Sn]. Figures 6; Tables 1; References 7: 2 Russian, 4 Western, 1 Japanese.

UDC 536.722'631+546.784'23

#### **Thermodynamic Properties of Tungsten Selenide in a Broad Temperature Range**

907D0176E Kiev POROSHKOVAYA  
METALLURGIYA in Russian No 5, May 90 pp 53-56

[Article by A. S. Bolag, Zh. A. Trofimova, and A. A. Yanaki, Institute for Materials-Science Problems, Ukrainian SSR Academy of Sciences]

[Abstract] The heat capacity of tungsten diselenide was measured by an adiabatic method at 60 to 300 K and extrapolated to 0 K. The enthalpy was measured by the method of mixtures at 400 to 1700 K. The measurements were used to calculate standard enthalpy, entropy, and reduced Gibbs free energy at 298.15 K, which were then used to derive the variation of heat capacity, entropy, and reduced Gibbs free energy with temperature at 298.15 to 1800 K. Since the heat capacity and enthalpy were found to increase monotonically with temperature within the entire temperature range, it is concluded that tungsten diselenide does not undergo phase transformations within this range. Tables 3; References 12: 9 Russian, 3 Western.

UDC 621.762:669.018.25

#### **Use of Acoustic-Emission Method in the Study of the Mechanism of Strengthening of Hard Alloys by Heat Treatment**

907D0176F Kiev POROSHKOVAYA  
METALLURGIYA in Russian No 5, May 90 pp 72-76

[Article by M. G. Loshak, L. I. Aleksandrova, and N. I. Gorodyskiy, Ultrahard-Materials Institute, Ukrainian SSR Academy of Sciences]

[Abstract] Changes in structure constituents of tungsten hard alloys bonded with 10 and 30 vol% nickel (alloys VK6 and VK20) resulting from optimal quenching (not

described) were studied and correlated with acoustic emission signals from specimens subjected to concentrated bending loads. It was found that quenching increases the strength and resistance to repeated loading because of additional dissolution of tungsten and carbon in the cobalt bonding phase, which increases the distance between the carbide grains. This strengthens the bonding

phase and decreases the strength of the carbide phase. Therefore the cobalt phase dissipates the energy of shock loads and is capable of withstanding a larger number of loads that destroy grain boundaries and carbide grains, thus increasing the energy required for plastic deformation. Figures 2; Tables 2; References 10: 9 Russian, 1 Western.



UDC 537.312.5

**Changes in InP, GaAs, and InAs Surface Morphology Under the Effect of Laser Radiation With a Threshold Flux Density**

907D0156A Moscow FIZIKA I KHIMIYA  
OBRABOTKI MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 20-23

[Article by K. K. Dzhamanbalin, A. G. Dmitriyev, E. N. Sokol-Nomokonov, Yu. I. Ukhonov, Chita and Leningrad]

[Abstract] The threshold flux density of laser irradiation, under which surface morphology changes occur, were determined experimentally and the corresponding temperatures in  $A^{III}B^V$  crystals were estimated; a model made it possible to evaluate the highest temperature which can be obtained under given experimental conditions and was employed in calculations. It was shown that surface morphology changes in the  $A^{III}B^V$  crystals observed under laser radiation were not related to the actual melting of the compound. The fusion-like morphological changes were probably caused by a crystal decay during the radiant heating to temperatures below the melting point. Tables 2; References 7: 3 Russian, 4 Western.

UDC 548.5+621.9.048.7+669.046.516.2:669.295

**Crystallization Front Morphology Variation Patterns in Titanium Alloys After Borating by CW CO<sub>2</sub> Laser Beam**

907D0156B Moscow FIZIKA I KHIMIYA  
OBRABOTKI MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 24-30

[Article by S. P. Velikevich, N. A. Bereza, S. V. Bushik, Minsk]

[Abstract] Crystallization front morphology variation patterns after boration by CW CO<sub>2</sub> laser radiation were examined theoretically and experimentally in the VT23 titanium alloy. The numerical dependence of the temperature gradient/growth rate ratio and cooling rate on the interface between the crystal and the melt on the molten pool depth was determined during the crystallization process, making it possible to estimate the range of critical values of the  $G/R$  parameter which characterizes the transition of a plane front to cellular and eventually to a cellular-dendritic front. Earlier conclusions find that the  $G/R$  parameter on the crystallization front is the controlling variable for the type of structure forming from the melt has been confirmed. Figures 4; References 9: 3 Russian, 6 Western.

UDC 539.219.3:539.234

**Breakdown Peculiarities of Thin Pt-Ni Metal Films Under the Effect of Laser Radiation**

907D0156C Moscow FIZIKA I KHIMIYA  
OBRABOTKI MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 39-43

[Article by S. M. Voloshko, A. B. Goncharenko, M. A. Nishchenko, S. I. Sidorenko, A. M. Shalayev, Kiev]

[Abstract] The failure of thin Pt-Ni and Ni-Pt films under the effect of millisecond-long laser pulses changes in the composition of irradiated films and their breakdown products by depth, as well as the effect of these processes on electrical resistance were examined. An analysis of bilayer Pt-Ni and Ni-Pt films on SiO<sub>2</sub> made it possible to establish the characteristics of the coat surface destruction by laser beam which amounts to the formation of small holes with a diameter less than the laser radiation wavelength. A component distribution of the bilayer composition and the intact surface by depth following laser irradiation and the dependence of this phenomenon on the specific irradiating power were also discovered. Figures 4; Tables 1; References 5.

UDC 539.04.019

**Structural Phenomena During Super-Deep Penetration of Metals by Particles**

907D0156D Moscow FIZIKA I KHIMIYA  
OBRABOTKI MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 51-55

[Article by A. K. Kozorezov, K. I. Kozorezov, L. I. Mirkin, Moscow]

[Abstract] Principal structural characteristics of materials subjected to the impact of a high-velocity particle flow were examined and the physical nature of super-deep particle penetration was considered. A broad range of materials, primarily steel of various compositions, was examined after an exposure to flows of metallic and nonmetallic particles. The structure of samples was examined by metallographic, electron microscopy and X-ray structural analyses. Curved channels with a diameter of several micrometers as well as filamentary cracks perpendicular to the channel axis were discovered on the surface. It was discovered that the super-deep penetration depends little on the mechanical properties of the target material. Examinations of the super-deep penetration of solids by particles may aid in the development of a number of new processes necessary for manufacturing volume-alloyed composite materials. Figures 4; References 6.

UDC 621.923.5:621.43-222.002.2

**Structural and Chemical State of Surfaces Formed During Antifriction Deformation Treatment**907D0156E Moscow FIZIKA I KHIMIYA  
OBRABOTKI MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 89-94

[Article by I. Kh. Chepovetskiy, S. A. Yushchenko, Kiev]

[Abstract] The method of applying solid lubricants by friction and holding them in place in a rough layer during the plastic deformation of microscopic surface irregularities in the course of antifriction-deformation treatment (ADO) helps to form an antifriction coat on the surface which increases the wear resistance of friction pair parts by 50 - 200 percent while simultaneously lowering the friction coefficient by up to 30 percent. Surfaces under study were treated by using various characteristics of antifriction pads under optimal conditions and examined under a reflected-light electron microscope. The results of a chemical analysis of the surface show that the antifriction coat on the samples under study contained all the antifriction pad elements. It was also discovered that there was no chemical interaction between the antifriction materials and the treated surface. The authors speculate that the improvement in the wear resistance of parts after the antifriction-deformation treatment was due to the formation of an antifriction coat and oxide films on the treated surfaces. Figures 5; References 9.

UDC 669.187.56.001.5

**Examination of Machinability of Spun Electroslag Casting Blanks From Austenite Steels and Alloys**907D0157B Kiev PROBLEMY SPETSIALNOY  
ELEKTROMETALLURGII in Russian  
No 2, Apr-Jun 90 pp 30-34

[Article by L. B. Getsov, Ye. I. Kendel, G. A. Boyko, A. V. Chernets, V. P. Lukyanets, Electric Welding Institute imeni Ye. O. Paton, Kiev and Proletarskiy Zavod Production Association, Leningrad]

[Abstract] The authors developed a method of making circular spun electroslag casting (TsEShL) from austenite steel 37Kh12N8G8MFB (EI481) and alloy KhN60VT (EI868) which do not undergo phase recrystallization during heat treatment. These castings were not as well machinable as forgings from the same steel and alloy, optimal casting cutting conditions were examined in order to identify the cause of poor machinability and develop measures to improve it. The dependence of the tool resistance on the cutting speed was used as the machinability criterion. In order to increase the machinability of castings, attempts were made to atomize their structure by exposing the crystallizing metal to dynamic action. Dynamic exposure made it possible to obtain a high structure atomization degree. Thus, it was possible to determine the effect of the

structure on the machinability of castings and draw the conclusion that the machinability of TsEShL with a fine crystalline structure is virtually the same as that of forgings. Figures 4; Tables 3.

UDC 669.187.56.002.2

**Making Hollow Billets From High-Nickel by Electroslag Casting Method**907D0157C Kiev PROBLEMY SPETSIALNOY  
ELEKTROMETALLURGII in Russian  
No 2, Apr-June pp 39-42

[Article by V. A. Tikhonov, B. I. Medovar, V. Ya. Sayenko, A. G. Bogachenko, G. M. Kalinin, N. T. Shevchenko, B. P. Vasilyev, V. A. Ryabinin, N. M. Shelestyuk, A. D. Ivanov, A. B. Korostelev, Electric Welding Institute imeni Ye. O. Paton, Kiev and Scientific Research and Design Institute of Power Engineering, Moscow]

[Abstract] To produce round billets from high-nickel alloys by the electroslag casting (EShL) method, slag systems must have a range of properties which simultaneously insure chemical composition stability, high metallurgical properties of refined metal, and the possibility to shape a satisfactory round billet surface. Methods of obtaining round billets by the EShL method from the high-nickel alloy KhN56MBYuD (EK62) using low fluorine nonsilica slags with additions of rare earth metal compounds were examined. Optimal compositions of slags with additions of highly active compounds were determined. The study demonstrated the high metallurgical properties of the electroslag metal. The resulting mechanical properties of electroslag metal met all the requirements. Thus, it was possible to make the conclusion about the possibility of using low fluorine nonsilica flux for making hollow round billets by the EShL method from high-nickel alloys containing highly oxidizable elements. Figures 3; Tables 1; References 7.

UDC 621.78.063.4

**Experiences With the Use of Polymeric Sodium Carboxymethylcellulose Quenchants**907D0174A Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 6, Jun 90 pp 2-4

[Article by A. A. Zhdanov, T. V. Okhrimenko, A. A. Popova, N. V. Dunayev, and S. Yu. Balandin, Atomkotelomash (not further identified) and Izhorskiy Zavod (Izhorsk Plant) Production Association]

[Abstract] Experiences at several Soviet plants with quenching of alloy steels in polymeric sodium carboxymethylcellulose covered by Romanian patents show that the cooling efficiencies of these quenchants lie between those of water and oil. In many cases quenching of steels

in polymeric quenchants, instead of in oil, yields superior strength, ductility, impact toughness, and fatigue resistance, making it possible to substitute carbon or low-alloy steels for expensive alloy steels. The cooling rate of polymeric quenchants can be varied by varying the concentration of the polymer and additives in water. Other advantages of polymeric quenchants include their environmental friendliness, their low fire hazard, their relatively high availability, low price, and their ability to be replenished when they are exhausted. The disadvantages of the polymeric quenchants include the fact that they become exhausted during use and require replenishment and that their use requires specialists familiar with their preparation and properties. Figure 1; Tables 3; References 4: 2 Russian, 2 Romanian.

UDC 621.785.545

#### **Surface Hardening With Inductive Heating of Differential Pinion Gears of MAZ Automobiles**

907D0174B Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 6, Jun 90 pp 9-13

[Article by P. S. Gurchenko, V. M. Bykov, and Yu. I. Shumakov, Minsk Automobile Plant and UkrNIIMET (Ukrainian Scientific-Research Metallurgy Institute)]

[Abstract] A patented gear-surface hardening setup is described in which the pinion gear to be hardened rotates in a vertical plane and simultaneously executes an up-and-down motion in such a manner that a constant distance is maintained between the stationary heating inductor and the surface of the teeth and the space between the teeth. The teeth and the inductor are submerged in a stream of water so that the surfaces heated by the inductor are quenched as they travel past the inductor. The constant distance between the inductor and the surfaces being hardened ensures uniform heating and consequently uniform hardening and depth of hardening. Figures 6; Tables 1; References 5 Russian.

UDC 621.785

#### **Control of Cooling Rate in Quenching of Steels**

907D0174C Moscow METALLOVEDENIYE I  
TERMICHESKAYA OBRABOTKA METALLOV  
in Russian No 6, Jun 90 pp 16-17

[Article by L. I. Bershteyn, A. S. Siper, and Yu. L. Bershteyn, Uralvagonzavod Production Association and Nizhniy-Tagil Department of the Ural Polytechnic Institute]

[Abstract] A unit for slowing down the rate of cooling in water-quenching of steel by passing electric current through the workpiece is described. Experiments with the unit show that its use for reduction of the cooling rate near the martensite temperature improves the ductility and hardness of steel and reduces the quenching stresses. Figures 4; Tables 1; References 2 Russian.

UDC 621.791.052:620.17

#### **Effect of Detonation Coatings on Fatigue Strength of Parts**

907D0176D Kiev POROSHKOVAYA  
METALLURGIYA in Russian No 5, May 90 pp 37-41

[Article by A. I. Zverev and L. N. Kopetman, Kiev]

[Abstract] Fatigue and shear bond-strength tests on cylindrical carbon-steel specimens detonation-coated with PG-AN9 and PG-AN12 bronzes and nickel are reported. The fatigue strength of specimens coated with the PG-AN9 bronze was found to be slightly higher than that of the specimens coated with the PG-AN12 bronze and slightly lower than that of uncoated specimens. Nickel-coating results in a sharp fatigue-strength drop. Delaminations of the coatings were found near fatigue cracks. A considerable variation in shear bond-strength was found along the specimens, and the shear bond-strength of nickel coatings was found to be much lower than that of bronze coatings. It is concluded that fatigue tests are more reliable than bond-strength tests for predicting the service life of coated parts operating under cyclic loads. Figures 6; Tables 3; References 6: 4 Russian, 2 Western.

UDC 621.791.3:537.525.5

**Arc Brazing in Vacuum With Powdered Composite Solder Application***907D0156F Moscow FIZIKA I KHIMIYA  
OBRABOTKI MATERIALOV in Russian  
No 2, Mar-Apr 90 pp 99-104*

[Article by V. M. Nerovnyy, R. M. Rogov, Moscow]

[Abstract] The heating pattern of powdered composite solder was estimated both in the plasma flux inside the outer arc discharge column with a hollow cathode and on the anode in a vacuum. Studies were carried out in a vacuum chamber within a 0.1 - 0.06 Pa pressure range using a burner with a straight hollow cylindrical cathode made from tantalum foil. An analysis of experimental data showed that the radial heat flux distribution in the outer hollow cathode column and the radial current density distribution on the anode could be described with sufficient accuracy by the normal distribution law. It was established that the heat flux density values in the outer plasma column in the hollow cathode during brazing in a vacuum are 100 to 1,000 times lower than those on the anode. Analytical and experimental studies of the powdered composite solder particle heating showed that heating the particles to the brazing temperature during electric contact with the part was the most efficient. Figures 3; References 12.

UDC [621.791.754'293.053:669.285]:620.17:539.38

**Character of Ductility Changes of Molybdenum Alloy MCh-2 During Welding***907D0161A Kiev AVTOMATICHESKAYA SVARKA  
in Russian No 5, May 90 pp 25-28*

[Article by engineer V. V. Kasyan, candidate of technical sciences Ye. A. Asnis, and director of technical sciences M. M. Nerodenko, Electric Welding Institute imeni Ye. O. Paton, USSR Academy of Sciences]

[Abstract] A vacuum dilatometer that permits photographic observation and measurement of shrinkage, elongation under applied tensile stresses, and cracking of high-melting and reactive metals under simulated welding conditions was used to study the mechanism responsible for changes in ductility of molybdenum alloy MCh-2 that lead to cracking of the welding seams under stresses that arise during solidification and cooling. Minimum ductility was observed at the moment of completion of solidification. Upon cooling, the ductility increases to a maximum and then falls off, finally resulting in cracking. Metallographic observation leads to the following explanation of ductility changes and cracking: At the solidification temperature, the simulated seam deforms under applied tensile stresses by grain deformation. Upon cooling from the solidification temperature, it also begins to deform by intergranular slips. Finally the grain deformation ceases and the seam begins to deform purely by intergranular slips, which leads to cracking. It is

concluded that this mode of deformation and cracking of alloy MCh-2 is due to its large content of interstitial impurities which segregate at the grain boundaries below 1900°C. Figures 8; References 5 Russian.

UDC [621.791.754'293.052:669.295]:620.18

**Optimization of Microstructure of Welded Joints in Titanium Alloys Based on the  $\beta$ -Solid Solution***907D0161B Kiev AVTOMATICHESKAYA SVARKA  
in Russian No 5, May 90 pp 28-31*

[Article by candidate of technical sciences M. A. Khorev, VIMO Scientific and Production Association]

[Abstract] The high hardenability, strength, and ductility of metastable  $\beta$ -titanium alloys can not be consistently obtained in welded joints because of the nonuniform chemical composition and therefore nonuniform decomposition of the  $\beta$ -solid solution during aging. This can be remedied by multialloying with elements that distribute themselves differently in the course of dendritic segregation and by appropriate heat treatment. A study is reported on the structure and mechanical properties as a function of heat treatment of argon-arc and electron-beam welded joints of a titanium-aluminum-molybdenum-vanadium-chromium-zirconium metastable- $\beta$  alloy containing a sum of  $\beta$ -stabilizing elements equivalent to 16.5 percent molybdenum. Annealing at 800°C and furnace-cooling; annealing at 750°C and furnace-cooling; water-quenching from 730°C and aging for 10 hours at 450°C; and annealing at 730°C, furnace-cooling, and aging for 10 hours at 450°C produced different amounts of  $\alpha$  and  $\beta$  phases and different mechanical properties. The best combination of strength (UTS of 1200 to 1220 MPa in the weld and 1250 to 1290 MPa in the base metal), ductility (bend angle at failure of 37 to 42 degrees in the weld and 50 to 55 degrees in the base metal), and impact toughness (0.15 to 0.19 MJ/m<sup>2</sup> in the weld and 0.12 to 0.16 MJ/m<sup>2</sup> in the base metal) was obtained by annealing at 730°C ( $\alpha + \beta$  region), furnace-cooling, and aging for 10 hours at 450°C. This treatment produces fine precipitates of the  $\alpha$ -phase that are uniformly distributed in the base metal, the seam, and the HAZ. Based on this study, recommendations are made regarding the heat treatment of other  $\beta$ -titanium alloys. Figures 3; Tables 3; References 4: 3 Russian, 1 Western.

UDC [621.791.754'293.052:669.295]:620.194

**Stress-Corrosion Cracking of Welded Joints in a High-Strength Titanium Alloy***907D0161C Kiev AVTOMATICHESKAYA SVARKA  
in Russian No 5, May 90 pp 31-36*

[Article by engineer A. A. Trufanov, director of technical sciences R. K. Melekhov, Lvov, candidate of technical sciences O. D. Smiyan, Kiev, and engineer V. A. Sher, Leningrad]

[Abstract] A study is reported on the effect of manual and automatic argon-shielded arc welding and the oxygen content of the metal on the static crack resistance and the susceptibility to stress-corrosion cracking of an experimental Ti-6Al-1.5V-6Zr alloy in a 3 percent salt solution acidified with HCl to pH 1. The tests were carried out on specimens cut from welded heavy plates and notched in the weld metal or in the heat-affected zone to simulate incipient cracks. The fracture-ductility characteristic  $K_Q$  and the crack-resistance criterion  $K_{sc}$  were determined. It was found that  $K_Q$  for the base metal, determined by static loading in air, decreases with increasing oxygen content from 132.7 MPa  $\times$  m<sup>1/2</sup> at 0.08% O to 62.3 MPa  $\times$  m<sup>1/2</sup> at 0.27% O. The fracture-ductility characteristic  $K_{sc}$  of the specimens notched in the seam obtained by automatic and manual welding is much higher than those of the manually and automatically welded specimens notched in the HAZ. The crack-resistance criterion  $K_{sc}$  of the base metal in the salt solution decreases with increasing oxygen content of the alloy from 67.1 MPa  $\times$  m<sup>1/2</sup> at 0.08% O to 28.1 MPa  $\times$  m<sup>1/2</sup> at 0.27% O. The seam metal was found to be the least susceptible and the base metal the most susceptible to stress corrosion cracking in the salt solution. The high resistance of the seam is attributed to the high ductility of the welding-wire metal. Automatically welded seams and HAZs were found to be less susceptible to stress-corrosion cracking than the manually welded seams and HAZs. The results are explained in terms of the distribution of alloying elements and impurities within the weld zones during welding. It is concluded that neither manual nor automatic argon-shielded arc welding lowers the resistance of the Ti-Al-V-Zr alloy to stress-corrosion cracking in sea water. Figures 7; Tables 3; References 10: 8 Russian, 2 Western.

UDC 621.791.754'293:[669.295+669.296.5]:620.193.28

### Corrosion Resistance of Welded Joints Between a 2.5 Percent Nb Zirconium Alloy and Titanium in Acids

907D0161D Kiev AVTOMATICHESKAYA SVARKA in Russian No 5, May 90 pp 41-44

[Article by candidate of technical sciences S. G. Polyakov and engineers L. M. Onopriyenko, L. I. Adeyeva, and K. G. Grigorenko, Electric Welding Institute imeni Ye. O. Paton, USSR Academy of Sciences]

[Abstract] Corrosion-rate measurements of arc butt welds between alloy N-2.5 (Zr containing 2.5 percent Nb) and titanium VT1-O in 3, 5, and 50 percent sulfuric acid, 3, 5, and 20 percent hydrochloric acid, and 98 percent acetic acid, at 320 K and at boiling temperatures, are reported and compared with corrosion rates of the two base materials and their butt welds. The welds were prepared at speeds of 0.28 and 1.12 cm/s. The weld metal between the zirconium alloy and titanium was found to be much more corrosion resistant in mineral acids than titanium (because of its zirconium content of 40 to 60

percent) but less corrosion resistant than zirconium. Titanium dissolves completely in boiling 20 percent hydrochloric acid. In boiling acetic acid, the corrosion rates of titanium, zirconium, and the welds between these materials are nearly the same and vary between 0.001 and 0.002 mm/year. Increasing welding speed was found to increase the corrosion rate of titanium-zirconium welds in mineral acids. Figures 5; Tables 2; References 5 Russian.

UDC

[621.791.763.1.03:621.9.114:65.011.46.002.237]:629.113

### Ways of Increasing the Effectiveness of Automation of Tack-Welding in Automobile Manufacture

907D0161E Kiev AVTOMATICHESKAYA SVARKA in Russian No 5, May 90 pp

[Article by engineer Yu. A. Kartavin, Gorkiy Polytechnic Institute]

[Abstract] Topics discussed in the article were the economic, technical, and personnel problems that hinder cost reduction and quality improvement by automation of tack-welding of car bodies and truck cabs with industrial robots at Soviet automobile plants. Imported robot-equipped welding lines are very expensive and they consume "hard" rubles. In view of their high cost, the labor savings they offer are insufficient to amortize them. Equipment of imported flexible welding lines with domestic PR601/60 robots offers a 10 percent cost advantage over turnkey imported lines, but the end benefit is doubtful because the domestic robots are less reliable. For example, the rate of breakdowns and downtime of a line equipped with domestic robots PR601/60 is 50 percent higher than that of a line equipped with imported Unimet robots. The welding costs can be lowered by better training of maintenance personnel, development of improved domestic equipment, the use of simpler robots without unnecessary degrees of freedom, in place of universal robots, and design of car bodies and truck cabs that are more suitable for automated welding. References 2 Russian.

UDC 621.052.192.47

### Effect of Barium on the Mechanical Properties of Filler Metal in Welding With Calcium-Fluoride-Coated Electrodes

907D0162A Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 90 pp 8-9

[Article by V. D. Makarenko and I. D. Morgun, Tyumen Industrial Institute]

[Abstract] The effect of the addition of 0.5 - 5 percent of Ba powder to the outer calcium fluoride coating of welding electrodes on the phosphorus content, the Charpy impact toughness, the critical stress-intensity factor  $K_{Ic}$ , and the critical crack-opening factor  $\delta_c$  of the

filler metal in welding of high-strength low-alloy steels (steels 09G2S and 10KhSND) for low-temperature service is reported. The mechanical tests were carried out at -70 - 20°C. Addition of 0.5 percent Ba to the electrode coating has no significant effect on the phosphorus content of the filler metal, whereas addition of 1 - 4 percent Ba lowers the phosphorus content of the filler metal from an average of 0.022% without Ba to 0.008 - 0.012% with Ba. The impact toughness of the filler metal at -70°C at first increases with the Ba content of the electrode coating from 32 - 37 J/cm<sup>2</sup> at 0.5 percent Ba to 55 - 61 J/cm<sup>2</sup> and then falls to 21 - 29 and 11 - 18.5 J/cm<sup>2</sup> at 4 and 5 percent Ba, respectively. Similar relationships were found at other test temperatures.  $K_{Ic}$  and  $\delta_c$  increase with increasing Ba content and decrease with decreasing temperature. The optimum Ba content is 1 - 3 percent. Figures 1; Tables 5; References 6: 5 Russian, 1 Western.

UDC 621.793.7

### Study of Adhesion of Aluminum-Oxide Detonation Coatings by Design of Experiment

907D0162B Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 90 pp 14-15

[Article by V. A. Simonenko, A. I. Dolmatov, O. D. Parakhovskiy, and M. I. Livshits, Kharkov Aviation Institute imeni N. Ye. Zhukovskiy]

[Abstract] A previously described apparatus was used for detonation coating of steel 45 plates with G-00 aluminum-oxide powder, keeping the oxygen, acetylene, and nitrogen flow rates constant at  $0.62 \times 10^{-3}$ ,  $0.023 \times 10^{-3}$ , and  $0.02 \times 10^{-3}$  m<sup>3</sup>/s, respectively, and a blowing pressure of 0.28 MPa. A previously reported method of multivariable mathematical planning of experiment was used to study the effects of the workpiece speed (variable  $x_1$ , 0 and  $30 \times 10^{-3}$  m/s), the nozzle-to-workpiece distance ( $x_2$ , 0.1 and 0.15 m/s), and the incidence angle ( $x_3$ , 60 and 90°) on coating adhesion. Variation of these factors also simulates the coating of intricately shaped workpieces, when the distance and the incidence angle change with the workpiece shape when the nozzle is stationary. A regression equation ( $Y = 2.9 - 0.225 x_1 + 0.575 x_2 + 0.375 x_3 + 0.05 x_1 x_2 + 0.1 x_1 x_3 - 0.05 x_2 x_3 - 0.025 x_1 x_2 x_3$ ) derived from experimental data gives a good agreement between predicted and experimental adhesion figures. The most important factor affecting the coating adhesion is the nozzle distance. The effect of the workpiece speed and the incidence angle is smaller. The optimum values of the nozzle distance, incidence angle, and workpiece speed are 165 - 175 mm, 75 - 90° and  $(1 - 15) \times 10^3$  m/s, respectively. Tables 1; References: 8 Russian.

UDC 621.791.75.034.621.791.754

### Torch for High-Speed Gas-Shielded Welding

907D0162C Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 90 p 23

[Article by V. V. Kalyuzhnyy, Voroshilovgrad Machinebuilding Institute]

[Abstract] In high-speed arc welding, the air encountered by the welding torch tends to deflect the protective gas stream towards the tail end of the welding pool, leaving the remainder of the pool unprotected. A nonconsumable-electrode welding torch is described which compensates for this deflection by directing the protective gas stream away from the vertical, in the welding direction. This compensation is achieved by means of a diverging nozzle threaded into a ball joint equipped with a passage for the protective gas and capable of swiveling in all directions. At low welding speeds, the relative air speed is too low to deflect the gas stream, and the nozzle is kept in the vertical position. This technology is patented (USSR authorship certificate 1342646) and offered for sale by the Voroshilovgrad Machinebuilding Institute. Figures 2; References 2 Russian.

UDC 621.791.052:620.193

### Corrosion Resistance of Chromium-Nickel Steel Welds in Alkaline Media (Review)

907D0163A Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 5, May 90 pp 12-13

[Article by A. G. Aleksandrov, Zaporozhye Machinebuilding Institute imeni V. Ya. Chubar]

[Abstract] A literature review of selective corrosion and stress corrosion cracking of austenitic and two-phase austenitic-ferritic chromium-nickel steel welds is presented. The topics covered include: the effects of temperature, alkali concentration, service conditions, welding practice, heat treatment (removal of internal stresses to prevent stress-corrosion cracking), chemical composition of both the base metal and the filler metal, passivation by chromium, nickel, and copper, and structure of the filler metal. A considerable space is devoted to the beneficial effect of microalloying with yttrium on corrosion and mechanical properties. References 24: 21 Russian, 1 Japanese, 2 Western.

UDC 621.791.052:620.193.2

### Corrosion Resistance of Brazed Joints in Gas-Field Piping

907D0163B Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 5, May 90 pp 14-15

[Article by V. I. Khomenko, V. V. Karabanov, and N. G. Goncharov]

[Abstract] Corrosion of induction-brazed and welded pipe joints was studied in a solution containing 0.5 g NaCl and 1 g Na<sub>2</sub>SO<sub>4</sub> per liter by measuring the corrosion-depth profile, the polarization resistance, and the corrosion potential. The three measurement methods provided a good correlation. It was found that the seams brazed with an iron-manganese solder are more corrosion-resistant than the base metal. The reverse was found to be true in the case of welded joints. Brazed joints were

also found to be more resistant to cracking by gaseous and dissolved  $H_2S$  than welded joints and the base metal. This is attributed to the electrochemical effect of copper in the solder in the case of dissolved  $H_2S$  and to the formation of a copper sulfide film in the case of gaseous  $H_2S$ . Figures 2; Tables 3; References 6 Russian.

UDC 621.791.052:620.18:620.193.2

**Effect of Heat-Treatment Practice on the Structure and Corrosion Cracking of Welded Joints in Zirconium Containing 2.5 Percent Niobium in Corrosive Media**

907D0163A Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 5, May 90 pp 16-17

[Article by A. B. Goncharov, M. M. Nerodenko, M. L. Tkachenko, and L. I. Adeyeva, Electric-Welding Institute imeni Ye. O. Paton]

[Abstract] Welded-wire specimens were heated in vacuum for 2 and 10 h at 850 K ( $\alpha$ -region), 1020 K and

1270 K ( $\beta$ -region) and water-quenched from 1270 K prior to corrosion testing in boiling 98 percent acetic acid and boiling 70 percent sulfuric acid, as well as testing for stress-corrosion cracking under a load of  $0.9 \sigma_T$  in methanol containing 0.4 g/l of hydrochloric acid and in steam at 570 K. In acetic acid, the corrosion rate is practically independent of heat treatment and amounts to 0.001 - 0.005 mm/year. In sulfuric acid, the minimum corrosion rate (0.323 mm/year) was observed for joints quenched from 1270 K. It was about 1000 mm/year in the case of all other forms of heat treatment. The optimum heat treatment for welded joints for service in superheated steam is heating in the  $\alpha$ -region or a combination of quenching and heating for 10 h at 850 K. As-welded joints and those heated at 850 K resist stress-corrosion cracking for only 24 h. The resistance to stress-corrosion cracking increases to 850 and 3600 h after heating at 1020 and 1270 K, respectively. Quenching from 1270 K lowers the resistance to 168 h. The results are explained in terms of microstructure changes produced by heat treatment. Figures 4; Tables 1; References 9 Russian.

UDC 621.791.945.03(088.8)

**Mechanized Transportable Unit for Cutting of Hollow Blanks on Large Presses**

907D0136A Moscow

KUZNECHNO-SHTAMPOVOCHNOYE

PROIZVODSTVO in Russian No 3, Mar 90 pp 19-20

[Article by M. Ya. Brovman, I. G. Finkelshteyn, B. F. Savchenko, and F. I. Kaganovskiy]

[Abstract] A transportable unit is described which frees rams stuck within hollow tube blanks by cutting the blanks with oxygen torches without damaging the rams. The unit, which is transported with a crane, is equipped with two oxygen torches mounted on a vertically movable platform. The torches are remotely controlled by separate operators and are capable of making vertical and horizontal cuts in a blank that may be necessary to free the ram. Figure 1; References 6: 4 Russian, 2 Western.

UDC 621.771.6.001.8

**Fully Mechanized Line for Production of Ring Blanks**

907D0136B Moscow

KUZNECHNO-SHTAMPOVOCHNOYE

PROIZVODSTVO in Russian No 3, Mar 90 pp 20-23

[Article by F. M. Valyavkin, V. G. Mozerov, and I. A. Baybak]

[Abstract] A line consisting of a heating furnace, a pancake-preform hammer, and a ring-rolling mill for production of plain and contour ring blanks ranging from 250 to 1000 mm in outside diameter, 5 to 75 mm in wall thickness, and 20 to 300 mm in thickness is described. It is designed for short production runs, when the use of press-forged or cast blanks would not be justified in view of the expensive equipment required to produce them. The conveyance of the stock from the furnace to the hammer and of the blanks to the rolling-mill table is mechanized. The rolling mill, from mounting of the pancake preforms between the rolls to their removal and conveyance from the mill, is operated by one person from a control panel. The rolling process itself is semiautomatic or automatic, depending on the length of the production run. Figures 4; Tables 1; References 7: 4 Russian, 3 Western.

UDC 621.783:621.73.043

**Heater for Preheating of Forging Dies**

907D0136D Moscow

KUZNECHNO-SHTAMPOVOCHNOYE

PROIZVODSTVO in Russian No 3, Mar 90 pp 25-26

[Article by V. A. Osnovin, Yu. Ye. Tarasov, and A. V. Zarin]

[Abstract] Precision and reproducibility of closed-die forging requires maintenance of constant die temperature (and thus constant die dimensions) and of proper

difference between the die and the workpiece temperatures. A heating unit for preheating of dies and for maintaining their temperature during forging is described. The heating element consists of a length of an 8 mm thick nickel-chromium wire bent into a checkerwork of U-shapes joined with straps. The adjoining U-shapes lie in planes perpendicular to one another, which results in a large length of wire per unit volume of the checkerwork and a high heating rate. The installation and electrical connections of the heater are described. Figures 2; References 5: 3 Russian, 2 Western.

UDC 621.73:338.8.45.001.24

**Assessment of the Technology Level of Series Forgings Production**

907D0136E Moscow

KUZNECHNO-SHTAMPOVOCHNOYE

PROIZVODSTVO No 3, Mar 90 pp 28-31

[Article by candidate of technical sciences V. G. Lepikhov and A. A. Solovyev]

[Abstract] An analytical review of the literature dealing with the methods and results of quantitative assessment of efficiency of series forgings production in the transportable power-generation equipment industry subbranch is presented. The factors that are measured and expressed in the form of equations include: a general efficiency index, the percentage of automated production operations, the percentage of mechanized production operations, the utilization of production capacity, the use of standard tools instead of special tools, the tool life, the labor productivity, and the efficiency of utilization of materials and blanks. It is concluded that production efficiency can be increased merely by proper utilization of the experience gained within the subbranch. Figures 2; Tables 2; References 14 Russian.

UDC 621.735.32.06-52.001.8

**Industrial Robot for Sizing of Metalloceramic Bushings**

907D0136F Moscow

KUZNECHNO-SHTAMPOVOCHNOYE

PROIZVODSTVO in Russian No 3, Mar 90 pp 31-32

[Article by candidate of technical sciences G. A. Buryakov and S. V. Ananov]

[Abstract] An attachment to the industrial robot MP 9S for feeding bushing blanks onto the mandrel of a crank-type sizing press is described. The blanks are thrown upward from a feed chute in such a manner that they are threaded onto a holder arm in the form of a horizontal rod with a downward bend at its end. Then the robot moves the holder arm to the position in which the blanks



fall off and are threaded over the press mandrel. Two versions in which the holder arm executes either a reciprocal or a swing motion to place the downward bend (and the blank) above the press mandrel are described. The first version is faster, but it is unsuitable for feeding of small bushing blanks. Figures 3.

UDC 621.86.061(088.8):621.865.14:621.86.06

### **Eccentric Grip**

907D0136G Moscow  
KUZNECHNO-SHTAMPOVOCHNOYE  
PROIZVODSTVO in Russian No 3, Mar 90 pp 32-33

[Article by candidate of technical sciences N. V. Potekushin and F. A. Krasin]

[Abstract] A patented self-actuating eccentric device for gripping and transporting of sheets and plates in vertical orientation is described. The gripping force is provided by the closing of the eccentrics against the material being transported under the weight of the material, the force being proportional to the weight. The surfaces of the eccentrics are knurled to increase friction. The gripping force is released by wedge-shaped supports when the sheet or plate is delivered to its destination. Figures 3; References 3 Russian.

UDC 669.187.56.001.5

### **Development and Examination of Nonconsumable Cooled Metallic Electrodes for Electroslag Process**

907D0157A Kiev PROBLEMY SPETSIALNOY  
ELEKTROMETALLURGII in Russian  
No 2, Apr-Jun 90 pp 16-21

[Article by V. A. Yakovenko, Ye. V. Butskiy, V. N. Yarulin, S. V. Bogdanov, Electric Welding Institute imeni Ye. O. Paton, Kiev and Elektrostal Plant, Elektrostal]

[Abstract] Wear resistant copper electrodes with molybdenum or tungsten tips were made and tested under laboratory conditions in order to examine the energy conditions of their operation. To this end, the voltage, current, tip position in the slag bath, cooling water rate and temperature, and slag temperature were controlled. When a cold tip was immersed in slag with a 1,773 - 2,073 K temperature, a slag lining was frosted on its surface. The slag lining is firmly bonded to the tip surface and protects it from contact with liquid slag. On the basis of research results, industrial nonconsumable metallic cooled electrode designs were developed. These electrodes which are immune to electrolytic corrosion and erosion can be used for refining electrolytic manganese and refractory grinding chips. The electrodes are simple to maintain, reliable, and insure stable electroslag process. Figures 9; Tables 1; References 2.

UDC 621.74:669.35

### **Brass Tubular Electrodes for Rapid Production of Deep Apertures**

907D0179A Moscow TSVETNYYE METALLY  
in Russian No 4, Apr 90 pp 73-75

[Article by F. S. Seydaliyev and R. P. Klepikov]

[Abstract] The USSR uses modern imported electric erosion drilling machines, and now manufactures the model 4603 machine domestically, to produce deep, small apertures in draw dies and other parts. However, the thickwall brass electrodes with capillary center apertures required by these machines have not previously been manufactured there, forcing them to purchase electrodes for hard currency. Now, Giprotsvetmetobrabotka Institute has manufactured an experimental batch of thickwall brass tubes with outside diameter 0.30 - 1.0 mm and inside diameter 0.10 - 0.20 mm with good quality characteristics: outside diameter variations 0.002 - 0.004 mm, precision straightness, no helical traces or contamination of outside or inside surfaces. The tubes are manufactured by argon-arc welding of a brass strip with subsequent drum drawing without intermediate annealing. The authors call for rapid industrial production of these high-precision tubes for industrial use. Figure 1, References 4: Russian.

UDC 621.778.1.073

### **Superhard Material for Drawing of Refractory Metal Wire**

907D0179B Moscow TSVETNYYE METALLY  
in Russian No 4, Apr 90 pp 76-77

[Article by V. I. Veprintsev, V. V. Loparev, G. A. Adler, A. N. Mankov, and T. V. Makaagonova]

[Abstract] Studies at the All-Union Scientific Research Institute of Hard Alloys have created the SVG superhard material which has superior polishing properties to SVA-15Bu and ASB-6-1. The material can be used at up to 750 - 800°C, and is produced by high-pressure and temperature sintering of 95 percent diamond powder with hardening additives. The material has been tested in draw dies for drawing of tungsten wire. The material has longer tool life than the American compax material, but is less stable in operation than compax. References 4: Russian.

UDC 621.771.23:621.726

### **Structure and Properties of Joint Zone of Aluminum Alloys Clad During Casting**

907D0179C Moscow TSVETNYYE METALLY  
in Russian No 4, Apr 90 pp 77-79

[Article by N. D. Lukashkin and T. I. Bashkirova]

[Abstract] The structure and properties of joint zones were studied in bimetallic blanks made of the alloys

AMg6, V95, AMts and silumin with an aluminum interlayer. Specimens were made by casting at 780°C of aluminum alloy melts onto a solid aluminum plate coated with silumin containing 11 - 12 percent Si. It is

found that homogenization at 420 - 520°C can control the properties of the joint zone. The optimum homogenization temperature is 460°C, homogenization time is 24 hours. Figures 3.

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